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THE
PSYCHOLOGICAL BULLETIN

ATTENTION

BY KARL M. DALLENBACH
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As in the recent summaries of the work on attention,[1] the studies reviewed here will be classified under four headings: (1) studies concerned with the definition and fundamental nature of attention; (2) studies of some special aspect of attention, *e.g.*, range, conditions, fluctuation, levels, measurement, etc.; (3) studies of attention in relation to other phenomena; and (4) technological, or practical, studies.

1. Definition and Fundamental Nature

(a) *General.* Wolf (36), professor of logic and author of "The Oldest Biography of Spinoza," writes the article on Attention in the 14th edition of the *Encyclopedia Britannica.* His treatment is wholly inadequate; it betrays no knowledge on his part of the recent work and thought upon the subject. In defining the term he distinguishes between two uses: "in the narrow sense, which coincides with popular use, it means the mental process by which some object comes to be apprehended more clearly than before it was attended to; and in the wider sense, it denotes the mental processes in virtue of which anything becomes an object of consciousness at all as compared with the multitude of stimuli which never find entry into consciousness; although they are within reach of the observer." After illustrating briefly what these definitions mean, he discusses the conditions, kinds, duration, span, and abnormalities of attention. As his treatment of these special aspects is reported below under the proper headings, comment will be reserved until then. We may note here, however,

[1] This Bulletin, 1926, 23, 1–18; 1928, 25, 493–512.

that his references at the end of the article are limited to James' *Principles,* Pillsbury's *Attention,* Stout's *Manual,* and Ward's article on Psychology in the 1918 edition of the *Encyclopedia Britannica.*

Ford (10) proposes a definition of attention in terms of behavior. He suggests that attention be regarded as the antithesis of automatization, and as the "name for the beginning of a synthesis of reactions to a novel environmental pattern." His definition is not, he feels, antagonistic to the descriptive account of attention, but supplementary to it, because the coördination of reactions—or rather the lack of it—"seems to have certain signs which resemble the conditions described by past workers . . . as attention." He points, in support of this definition, to the results of the experiments on distraction. Distractors at first attract attention—that is, initial reactions under distraction are highly susceptible to interference from the new and hitherto unexperienced stimulus-combination—and the efficiency of the work performed is lowered. With the lapse of time the distractors lose their effectiveness and are not attended to—that is, the reactions are so closely integrated that they are capable of resisting interference—and the efficiency of the work is not affected. Ford obtains further evidence for this thesis from his own experiments upon distraction.

The difficulty with Ford's concept is that his definition of attention is limited to attention multiply determined, *i.e.,* to secondary or voluntary attention. His definition is not applicable to attention singly determined, *i.e.,* to primary or involuntary attention, or to attention habitually determined, *i.e.,* to derived primary or nonvoluntary attention. From a descriptive point of view, there is no difference between these three types or kinds of attention. Ford's attempt to define attention in behavioral terms must, therefore, be marked down as a failure.

Sen Gupta (27), after examining briefly the different theories of attention and finding them all wanting in some respect, advances a theory (which he traces to Sully, Stout, and Shand) that attention is "a process of organic adjustment—peripheral and central—which secures the perseveration of experiences" (p. 163). He bases his theory upon the attribute of duration, and calls it "the perseveration theory of attention." This theory, too, fails to take account of primary and derived primary attention (involuntary and nonvoluntary), besides imperfectly explaining secondary attention (voluntary). While it is an interesting attempt to describe attention in terms other than 'clearness,' yet, since attention does not show an

invariable relation with duration, it was doomed to failure from the outset.

Rodrigue (26) writes of attention as an activity of the will, being closely related to curiosity, and directed by imagination and reason. His exposition harks back to faculty psychology.

Boutan (3), in his principal experiments, attracts the attention of a prosimian (*Lemur macaco L.*). Because the animal showed evidence of fatigue when it had done no active labor, and since certain of the animal's reactions (regarded by many as manifestations of attention) were essentially of a reflex nature, Boutan decides that there is a difference between attention and alertness. He includes the intellectual reactions under the former, and the mass of unintellectual reactions under the latter. Attention is, therefore, for him an intellectual activity.

(b) *Kinds.* According to Wolf (36), attention may be classified either upon the basis of the kind of object attended to (*e.g.*, sensorial and ideational attention), or upon the basis of effort exerted (*e.g.*, spontaneous, voluntary, and involuntary). The more important and less inconsistent principles of classification are ignored.

Dobrinin (9) writes in Russian upon the question of types of attention.[2]

(c) *Clearness.* The effect of the mental processes by which we attend is, according to Wolf (36), to render the objects apprehended more clear. For Sen Gupta (27), however, clearness is not an essential feature of attentional experience.

(d) *Duration.* Sen Gupta's (27) perseverative theory of attention, discussed above, is based upon the attribute of duration.

2. Special Aspects

(a) *Range.* After an historical review of the traditional 'range of attention' experiment, Glanville and Dallenbach (13) raise the issue whether 'range' is a proper question to set to attention. In one series of tachistoscopic experiments, they endeavored to escape the cognitive complications of the traditional experiment by instructing the *O*s, who had been trained in the observation of attensity (*i.e.*,

[2] As the Russian language does not fall within the competency of the reviewer, and as a search in the French and German periodicals did not reveal a review of this or of the other Russian articles listed in the bibliography below, the mere mention of the Russian articles by title must suffice. It is a great pity, however, for many interesting and important facts are doubtlessly thus closed to us.

attributive clearness), to report merely upon the distribution of clearness during the moment of the exposure (*i.e.*, whether it was of one, two, or more levels). To determine how the range of report is affected by degree of cognition, they instructed the *O*s, in other experimental series, to report the number of stimulus-objects apprehended, to name the stimulus-objects apprehended (familiar and unfamiliar), or to describe the stimulus-objects apprehended. In the first series, number of stimulus-objects was found not to be a condition of the attentive distribution of consciousness. In the cognitive series, 'range,' defined as number of stimuli which has a probability of 50 per cent of being correctly reported, varied inversely with degree of cognition and degree of assurance, and directly with kind of material, duration of after-image, facility of verbal association, and color sensitivity. Since, moreover, clearness did not invariably correlate with fullness or accuracy of report, the authors conclude that "questions concerning the number of contents or part-contents that may be simultaneously experienced are questions, since cognition is inherent in report, that concern cognition and not attention."

This study also verified the three conscious patterns first described by Oberly. In the 'immediate' type, the reports are immediately returned. In the 'mediate' type, the reports are mediated by re-imaging or other ancillary processes. The 'immediate' type is divided into two subtypes: the impressions are apprehended either as separate units, or as groups. In accordance with Dallenbach's criticism of Oberly's "transformation" of these patterns,[8] they are termed 'unit,' 'group,' and 'mediate' apprehension.

This terminology was accepted by Brown (4) in her study of the effect of homogeneous and heterogeneous chromatic stimuli on the range of 'unit,' 'group,' and 'mediate' apprehension—thus ending a controversy of several years. She cut dots, 6.5 mm. in diameter, from yellow, blue, red, and green Hering papers, and pasted them on white cards. In three series of cards the dots were homogeneous in quality; in four, heterogeneous; and in every series were twelve cards with from 3 to 14 dots. The cards were exposed for 37.5 σ, in haphazard order and by means of a Whipple tachistoscope, 50 times each to two *O*s and 100 times each to three *O*s. The *O*s reported the number of dots seen, the degree of assurance (on a 5-point scale) of their judgments, and the method of determining their reports ('unit,' 'group,' or 'mediate' apprehension). Judg-

[8] K. M. Dallenbach. Dr. Oberly on "The Range for Visual Attention, Cognition, and Apprehension." *Amer. J. Psychol.*, 1925, 36, 154–156.

ments with assurance of less than 3 (the certainty of a "1 to 1 bet") omitted. The limens, computed by the method of constant stimuli, are largest for 'mediate' apprehension, intermediate in size for 'group' apprehension, and smallest for 'unit' apprehension; largest, again, for the homogeneous green, blue, and red series, and smallest for the homogeneous yellow series and the heterogeneous series containing yellow. In spite of the anomalous rôle of yellow, Brown concludes that "heterogeneity of chromatic stimuli tends . . . to reduce the magnitude of the limens for each of the three cognitive patterns."

Though studies on 'range of apprehension' do not, as Glanville and Dallenbach's results show, properly belong to the topic of attention, we nevertheless mention them here for historical reasons.

Crosland and Johnson's (6) study on range of apprehension is mistitled. The authors are not interested in the question of range (they do not even compute constants for their *S*s), but in determining how legibility of printer's type is affected by inter-letter hair-spacing and by the characteristics of individual letters—a topic still further removed from the scope of this review. We must note, however, their use of the technique of the traditional range-of-attention experiment, and their assumption of an invariable relation between report and legibility—an assumption disproved in range-of-attention experiments of the past decade. The conclusions regarding legibility are, therefore, unwarranted inasmuch as they transcend the results.

One result of this study, that "the percentage of letters correct in all respects decreases gradually and consistently from left to right," is favored, as Tinker points out, by the use of letter-series of various lengths (from 3 to 12 letters), "for responses are more uniformly correct with shorter series."[4] Crosland (5) wrongly interprets this comment as a criticism, as Tinker (30) shows.

Tinker, Roberts, and Jackson (31) study the relative efficiency of apprehension with definite and indefinite preparation. After practice with a definite preparatory signal of 2 sec., they determined the range of apprehension with a definite preparation of 2 sec., and an indefinite preparation of 2, 4, 8, 12, 16, 20, 24, and 32 sec. Computation revealed no reliable differences between spans with definite and indefinite preparation, nor with the various indefinite preparatory intervals.

Wolf's (36) answer to the question of range is "one." "When

[4] M. A. Tinker. Visual Apprehension and Perception in Reading. This BULLETIN, 26, 1929, 227.

objects . . . are exposed for a small fraction of a second . . . as a rule only one object is apprehended." If he were writing . . . attentive distribution of consciousness, the reviewer would . . . with him; but he is not. He is referring to the traditional . . . ment; and there he is in error, as Hamilton's experiments . . . marbles, Jevon's with beans, and Cattell's with lines, letters, . . . etc., and numerous later experiments repeatedly demonstrate.

Gundlach, Rothschild, and Young's (14) study may be mentioned because of its use of the method of the 'range of attention' experiment. Ten small electric lamps, arranged at equal int . . . ls around the circumference of an 18-in. circle, were flashed, in . . . bers from 2 to 9, at different rates. Immediately after the presentation, the *S*s (grammar school, high school, and university students) pointed to the lights in the order flashed. Accuracy of response varied with age, practice, and speed of presentation—results comparable to those previously obtained in this field. In their analysis of the functional processes involved, the authors say that they have ignored the traditional concepts of 'attention,' 'apprehension,' and 'memory-span,' because these concepts "too frequently serve to cover up ignorance and to obscure problems." They imagine that "the concept of 'set' has an advantage over these terms." With this point of view the reviewer finds himself in disagreement. The concept of 'set' is in a sorrier plight, as the authors themselves show by giving four very different meanings of it, than any of the "traditional concepts" that they reject.

(b) *Conditions.* Wilcocks (35) undertakes to demonstrate "that what is heterogeneous, in some respect or other, with the simultaneous or the more immediately foregoing contents of consciousness . . . attracts or holds attention," *i.e.,* that change is a condition of attention; and to test the validity of Selz's laws that attention is attracted by mere difference (*Distinktionsbeachtung*) and by unexpected and opposing difference (*Widerstreitsbeachtung*). To measure the effect of change upon attention by the accuracy of report, the color of one member of the stimulus-series is changed unexpectedly, an old member is replaced by a new member, one member is moved sudden . . . or one member is stationary while all the others move. All of these experiments show a "markedly increased memory effect for a heterogeneous content unexpectedly introduced among a group of otherwise homogeneous content," and Wilcocks interprets this increase "as being due to a superior degree of attention having been

to the heterogeneous content" (p. 280), and as effects occur in agreement with Selz's laws.

measure the effect of change upon attention by reaction-time, a noise, sounding while *S* is performing simple reactions, is suddenly interrupted, the color of the reaction-stimulus (one of 4 or 12 simultaneously exposed letters) is unexpectedly changed, or the color of the reaction-stimulus (one of 4 simultaneously exposed letters) is the only one not changed.

The cessation of the noise lengthened the reaction-time, corroborating the influence of an unexpected heterogeneity in drawing attention. The other results, however, are equivocal; when a change is introduced, the reaction is sometimes lengthened, and at other times shortened. To explain these exceptions to Selz's laws, Wilcocks develops a theory "resting, in part, on a hypothesis stated by Henning with regard to an accumulation of energy, in a limited area, consequent on the temporary inhibition of one excitation by another not congruent with it." His results and the theory he bases upon them involve the gratuitous assumption that retention and reaction-times measure attention.

Friedline and Dallenbach (11) investigate distance from the point of visual fixation as a condition of attention. The attentional value of the different distances of two stimulus-objects, alike in every other respect, is determined by the intensity at which the two objects are reported equally attense or clear. The results, calculated by the method of constant stimuli, show that stimulus-objects near the point of fixation have an attentional advantage over objects further removed, and that stimulus-objects to the left of fixation have an advantage over those placed symmetrically to the right of fixation—thus corroborating earlier results that position is also a determinant of attention.

Glanville and Dallenbach (13), in the study reported above, indicate (p. 216) that quality of post-exposure-field, *i.e.*, whether light or dark, conditions attentive distribution.

Wolf (36), following tradition, classifies the conditions of attention as objective and subjective. The objective conditions are intensity, volume, duration, and novelty. The student of attention will be surprised to see novelty in this list until he discovers that Wolf uses that term, not in the accustomed sense of new, strange, or unusual, but in the sense of change. The subjective conditions, which "turn mainly on the momentary preoccupations or the permanent

interests of the individual mind," are idea in mind, attitude, and previous training.

Under this heading belongs also Tassy's (29) short paper on the natural stimulus for attention.

(c) *Fluctuation.* In the face of recent experimental work upon fluctuation of attention, Wolf (36) dogmatically states that we "cannot attend to a single thing for more than about a second without serious risk of falling into a hypnotic trance or similar pathological condition." There is not an iota of evidence for that statement. It is a pity that so much misinformation is given in an article that is supposed to be authoritative.

Dobrinin (8) writes a monograph upon the fluctuation of attention.

(d) *Levels.* In Glanville and Dallenbach's (13) tachistoscopic study of the range of attention reported above, the *O*s were directed in the first series of experiments to report merely the attensity of their experience during the moment of exposure. Though the multi-level type of consciousness was tacitly assumed and even suggested in the instructions, it was not reported a single time by any of the *O*s. Their reports show that their experience during the moment of exposure was divided into two levels of attensity: a clear focus and an obscure background (p. 213).

Five Russian articles deal with concentrated attention. Birsin (2) writes on the effect of muscle-training upon the capacity of concentrated attention; Bekhterev (1) considers the rôle of concentration in the process of associative-reflex activity; Ilyinski (16) investigates the physiology of concentration; Livshina and Shriftsetzer (17) deal with the group reaction in concentration of children of preschool age; and Oparina (21) reports the effect of disturbances of the functions of the central nervous system upon children's concentration.

Ilyinski (16), according to Shnirman's review,[5] uses a variation of Bekhterev's reflex method, and shows that concentration should not be regarded as a separate brain process, but as a differentiating activity of the perceptive part of the associative-reflex arc.

(e) *Measurement.* Wilcocks (35), in the experiment reported above, makes no attempt to justify his use of reaction-time as a measure of attention (probably because it cannot be done), but he does attempt to justify his use of memory. "Since, other things being equal, the retention of, and the ability to reproduce, a content varies directly with (not, necessarily, proportionately to) the degree

[5] A. L. Shnirman. *Psychol. Abstracts,* 1928, 2, 203 (No. 864).

of attention given the content at or after presentation, we are able to make use of the memory effect as a measure of the degree of attention which the content has had." But other things are not equal. As experiments have repeatedly shown—several of which are mentioned in this review—attention and report are not co-variables; clearness of content is only one of a number of factors conditioning report.

Philip (22) reviews the work that has been done upon the measurement of attention, and reports the results of his own efforts to devise a battery of tests that will measure attention. The battery was developed by experimenting upon 49 men, all senior college students, and was standardized by testing 1,600 school children from ten to nineteen years old.

Ford (10) proposes motor tonus as an index of degree of attention (p. 32).

(f) *Distraction and distribution.* Meisenheimer (19) inquires whether "central factors, *i.e.*, associations, always attach themselves to the focus of experience" (Zentrum des Erlebens). He sought to test this proposition experimentally by presenting stimulus-objects in peripheral vision, and noting how the *O*s' descriptions differed when attention was directed to, and away from, the objects. He chose peripheral vision because object-meanings develop slowly there, a favorable opportunity being thus offered for studying the development of meaning and of the conditions underlying it.

The fixation-point was placed 0°, 3°, 6°, or 12° to the right of the exposure-window and at distances of 31.4, 94.2, and 188.4 cm. from *O*. Typewritten digits and Landolt broken rings were exposed—but the results with the rings are not reported because of lack of space. The experiments were performed in a dark room, and the exposure-field was illuminated by a light which was controlled by an electrical key at *O*'s desk.

In Part Ia, *O* was directed to keep his eyes upon the fixation-point, but to attend, as a teacher does to a pupil, out of the corner of her eye, to the exposure-window, and to report immediately after the exposure (the length of which *O* was allowed himself to determine) the course of his experience. An analysis of the reports revealed seven steps or levels of cognition.

Slight changes were made both in apparatus and in procedure in Part Ib. A Hipp chronoscope was attached to the electrical key so that the time of illumination could be measured; only the shortest fixation-distance was used. In addition to the instructions of Part Ia, *O* was told to release the key as soon as he perceived a definite object

in the exposure window. The time of the first definite impression varied greatly for the different *O*s, but it increased for all with size of exposure-angle.

In Part II, *O*'s attention was directed away from the exposure-window to some other designated part of the exposure-field. Digits were exposed in both places, and the *O*s, most of whom were trained in introspection, gave complete reports of their experience. An analysis of these reports revealed five descriptive levels: one lower than the lowest found in Part I, and the other four agreeing with the first, second, third, and seventh steps of Part I.

The results reveal two facts which Meisenheimer believes to be contrary to all the existing theories of attention: (1) attention is primarily the experience of a turning-impulsively-upon, with which the phenomenological focus co-varies; and (2) all phenomena appear for the first time in the focus of experience and are developed only there; but after their first appearance they may be continued outside the focus of experience in a wider conscious field and there remain, where attention may again be turned upon them.

The exposition is needlessly complicated by the use of numerous arbitrary abbreviations. The provincial nature of the study is shown by the fact that every one of the 45 references in the bibliography is German.

After an historical and critical survey (far from complete) of the experiments upon distraction, Ford (10) reports experiments of his own. His distractors are a phonograph and an automobile horn; his measures of the effect of distraction are: (1) efficiency of work, measured by time and accuracy of adding a series of single-digit numbers scattered haphazardly in a row of mixed letters, (2) writing-pressure, (3) respiratory changes, and (4) vasomotor changes.

A series of 6–8 control experiments precedes and follows a series of 6 distraction experiments. The 6 experiments immediately preceding and immediately following the distraction series are used in computing the results. There are 17 *S*s (Ford says 16, but his data show the results of 17) in the experiments with phonographic distraction, and 41 *S*s in those with the automobile horn. The data for every position within both the control and the distraction series are averaged separately and curves are plotted. The results are: (1) initial addition takes longer than any later addition having constant environmental stimulus-patterns; (2) there is a slight tendency for more errors to be committed in the first half of a given homogeneous period than in the second half; (3) writing-pressure

and addition-time show a reliable positive correlation of 0.55; (4) vasomotor concomitants show initial effects, which go through gradient changes as the same type of work continues under constant environmental stimuli; and (5) fast workers quickly become automatized, slow workers only gradually. Two of Ford's diagrams (p. 24) appear to the reviewer to be mistitled. The diagram for the "fast workers" shows a slower addition-time than the diagram for the "slow workers."

One of Wilcocks's (35) experiments in the study reported above is concerned with the effect of distraction upon attention. He uses the simple visual reaction-time as a measure of the effect, and the cessation of a concomitant auditory stimulus as the distraction. A series of 10 reactions was performed while a comparatively loud noise sounded close to *S*. Just before the stimulus was given for the eleventh reaction, the noise was suddenly interrupted. The numerical results and the introspective reports both show that "attention was attracted to the sudden cessation of the noise."

An adaptation of Piorkowski's attention-fatigue meter is described by Verwoerd (32), who believes that it successfully measures the distribution of attention. He did not, however, find (33) the apparatus suitable for determining the effect of fatigue under disturbed attention. These studies are reported fully below.

Hovey (15) in a study of the effects of general distraction on records made in the Army Alpha Intelligence Test, concludes: (1) higher mental processes are comparatively unimpeded by distraction; (2) intelligence is not related to susceptibility to distraction; (3) there are no individual differences in susceptibility to distraction; and (4) true mental ability is more nearly approximated under distraction than under standard conditions.

Skaggs (28) shows, from a study of Hovey's data, that the distractors have a detrimental effect when practice is taken into account, and that Hovey's conclusions are not warranted.

Miles and Terman (20) review and comment upon the distraction experiments in word-association (pp. 174–179) that reveal sex differences.

Mandeville (18) discusses the causes of distraction, and gives practical suggestions for overcoming it.

(g) *Abnormalities.* Abnormal forms of attention, according to Wolf (36), are scattered attention and fixed ideas. The abnormalities are, in the opinion of the reviewer, more a matter of association than attention.

3. Relation to Other Phenomena

(a) *Intensity.* Wolf (36) states that clearness and intensity are different and, to a certain extent, independently variable aspects in the apprehension of objects.

(b) *Attention and association.* Wheeler (34) traces the development of the concepts of attention and association from the epistemological theories of the Continental rationalists and the British empiricists to the present time. He holds that these concepts have been used from these different points of view to account for the same set of facts, *i.e.*, "the orderly grouping and seriation of detail in mental life" (p. 2). The two schools faced the same logical problems, and they reached different solutions because "each allowed its epistemological interests to dictate its psychological system-making" (p. 5).

In spite of the faults of the apperceptionists and the associationists, the problem they faced is as alive today as at the time they were first confronted with it. If a systematic psychology is to be built, it cannot thrust either solution aside, for the logic which compelled them "to search for a common denominator in terms of which to envisage continuity and unity in complex mental life is as vital and legitimate today as it was then" (p. 6). That is Wheeler's thesis, and he devotes the rest of the paper to defending it. His conclusion is that "association is the problem of pattern and attention is the problem of the form and limits of pattern" (p. 17).

The exposition is marred by inaccuracies and by many misstatements of fact and theory. For example, Wheeler's statement that "Wundt discarded the two-level notion of conscious and subconscious and substituted for it the notion of focus and margin" (5) is not only inaccurate, but betrays a complete misunderstanding of Wundt. Focus (*Blickpunkt*) and margin (*Blickfeld*) are merely metaphors. Wundt used them, as Fortlage, Lotze, and Tucker did before him, to illustrate the difference between the perceived and apperceived levels of consciousness—a difference first pointed out by Leibnitz. Wheeler's difficulty with 'fringe' and 'margin' is entirely of his own making. 'Fringe' does not have to become 'focus' in order to be observed. Again, Wheeler misunderstands and misstates Titchener. Titchener did not regard attention as a process, nor 'attensity' as a dimension of consciousness. Wheeler categorically denies the distinction between attributive and cognitive clearness, but does not give the evidence upon which he based this judgment. His statement that the "distinction is untenable" is sheer dogmatism.

(c) *Attention, concept, and judgment.* Prengowski (25) considers attention, concept, and judgment together, because he finds close relationships among them. His treatment of the three phenomena is logical rather than experimental, and philosophical rather than scientific. The study is of no great interest to the student of attention.

(d) *Motor phenomena.* Ponzo (24) shows rather conclusively that the respiratory changes accompanying sensory attention are due, not to attention, but to the aim or purpose of the sensory act. The changes, for example, accompanying attention to olfactory stimuli are very different from those accompanying attention to weak sounds. If attention were responsible for the changes, they would be the same in the two cases. The inspiration-expiration ratio decreases, he finds, in all kinds of mental activity, and is best explained, he believes, as a facilitative modification.

Ford (10) measures the effect of distraction upon attention by way of motor, respiratory, and vasomotor changes. He finds a positive correlation of 0.55 between the pressure used by his *S*s in writing the sums of the problems in addition and the time taken by them to make the additions. Since he regards a long addition-time as an indication of the lack of automatization and therefore of the presence of attention, he concludes that "we must abandon any theory that continuous and rapid work under noise conditions will be accomplished at a sacrifice of muscular energy" (p. 37). His pneumographic records show so many inhibitions of breathing that he finds it impossible to draw conclusions from them. The vasomotor records, obtained from a finger plethysmograph, show "that any change of mental processes, whether we call them attention, emotion, feeling, or what not, produces an initial constriction followed by gradual dilation" (p. 30).

4. Technological

(a) *Attention tests.* Verwoerd (32, 33) reports the results of two experiments with Piorkowski's attention-fatigue meter—an apparatus which is little known in America, but is in principle nothing more than a multiple-reaction apparatus. It consists of a rectangular box in the top of which there is a row of 10 small windows paralleled by a row of 10 reaction-buttons. White squares are pasted upon a black drum within the box in such a way that, when the drum is rotated, they will appear, in the various windows, one at a time and in irregular and haphazard order. The person being tested is directed

to react as soon as he sees the white stimulus-object by pressing the button opposite the window in which it appears. The number of stimulus-exposures and of correct reactions is automatically recorded by electrical counters. This apparatus, we are told, is widely used in Germany for testing attention.

Three assumptions, according to Verwoerd (32), underlie this use of the apparatus: (1) the distribution of attention is responsible for performance; (2) the reactions, in spite of their complexity, do not influence performance; and (3) either the correct reactions are evenly spread over the 10 buttons, or there is a high correlation between performance, as measured by the total number of correct reactions, and the distribution of attention. His problem was to test these assumptions. He required his *O*s, 25 in number, to report at the conclusion of the experiments the manner in which they performed the task. These reports, supplemented by *E*'s observations, were used as checks of the first two assumptions. The third assumption was checked by attaching electrical counters to every one of the reaction-buttons, thereby making it possible to measure performance separately at every position.

According to his results none of the assumptions is justified. The reactions soon became automatized and the *O*s performed the task in a state of inattention as efficiently as in the state of attention, or even more efficiently. The apparatus cannot, therefore, be used in the prescribed manner to test attention. It is at most merely a test of the distribution of marginal consciousness, and of automatic action. The distribution of the scores among the 10 positions revealed an 'even' and an 'uneven' type of performance. Since the performance of these two types was found to be incommensurate, a single basis of ranking the *O*s could not be obtained.

In an endeavor to utilize the apparatus for testing attention, he altered the method. He instructed the *O*s to react on the fourth button with the left hand when a stimulus-object appeared in any one of the 5 windows to the left, and on the seventh button with the right hand when the stimulus-object appeared in any one of the 5 windows to the right. Since the *O*s did not under these conditions become habituated or react automatically, he concludes that the apparatus is serviceable when used, by his modified method, for testing the distribution of attention.

The distribution of performance among the 10 positions (how this was obtained is not clear, as the *O*s reacted only on the fourth and seventh buttons) varied as before. 'Even' and 'uneven' types

of performance were found. Consequently, a single basis of evaluating performance could again not be given.

Using this modified procedure, Verwoerd (33) undertook to discover the effects of fatigue upon the distribution of attention. Various effects were distinguished: (1) the performance as a whole suffers; (2) the unevenness of distribution increases, though the general level of performance remains the same; and (3) the distribution is narrowed, though the general level again remains unchanged. On the whole, however, Verwoerd finds that Piorkowski's apparatus "is not suitable for testing fatiguability where sustained distribution of attention is necessary, even if the apparatus is so altered that a distribution of attention is really obtained and that the evenness of such distribution can be checked."

Mme. Piéron (23) standardized Toulouse and Piéron's modification of Bourdon's letter-cancellation test. In the modified form two symbols are cancelled in a list of 1,600, composed of eight different kinds. The test serves as the attention-test in a battery designed for professional orientation. Norms were established for 1,091 Paris school children (489 girls and 602 boys).

Gamsa and Salkind (12) compare and evaluate the results obtained from (1) Rybakoff's color-counting test, (2) Rybakoff's square-and-cross counting test, (3) Schultze's number-square test, (4) Toulouse and Piéron's symbol-cancellation test, and (5) Rossolimo's distribution-of-attention test. These five tests were given to 90 girls (nine, twelve, and fifteen years of age) and to 50 women. Quartile records are furnished for every test, and inter-correlations for the adult scores are computed between every two tests. The relative gains vary considerably among the different ages and among the different tests. The correlations among the tests, though all positive, are slight, varying between 0.09 and 0.37.

Philip's (22) battery of attention-tests, devised especially for use in the schoolroom, includes variations of the familiar tests of number-span, mental multiplication, mental addition, alphabet, and cancellation. The battery was given to 1,600 school children, from ten to nineteen years of age, and performance in every test was separately computed for every age. The curves of performance in most of the tests reach a plateau at the age of fifteen. A correlation of 0.09 was obtained, from a sample of 243 children, between mental score and 'attention score' as measured by this battery.

(b) *Hygiene of attention.* De Lambert (7) writes on the

hygiene of attention, in the belief that attention is an activity that can be controlled through conscious self-regulation.

REFERENCES

1. Bekhterev, V. M., [The Rôle of Concentration as a Dominant in Processes of Associative-Reflex Activity.] *Voprosy izucheniya i vospitaniya lichnosti*, 1927, **1**, 3–18.
2. Birsin, G., [Muscle-Training to Raise the Capacity of Concentrated Attention.] *Izvestiya fizicheskoi kulturi*, 1927, **5**, 4–5.
3. Boutan, M. L., Quelques observations sur l'attention chez un Prosimien (Lemur macaco L.). *C. r. cong. soc. savantes*, 1928, 347–366.
4. Brown, A. F., The Relation of Heterogeneous and Homogeneous Chromatic Stimuli in the Range of Visual Apprehension Experiment. *Amer. J. Psychol.*, 1929, **41**, 577–594.
5. Crosland, H. R., The Influence of Letter Position on Range of Apprehension: A Reply to Dr. Tinker. *Psychol. Bull.*, 1929, **26**, 376.
6. Crosland, H. R., and Johnson, G., The Range of Apprehension as Affected by Inter-Letter Hair-Spacing and by the Characteristics of the Individual Letters. *J. Appl. Psychol.*, 1928, **12**, 82–124.
7. De Lambert, E., L'hygiène de l'attention par l'autorégulation consciente. *Bull. soc. d' étude des formes humaines*, 1928, **6**, 353–375.
8. Dobrinin, N. F., [Fluctuations of Attention]. Moscow, 1928, pp. 104.
9. Dobrinin, N. F., [The Question of Types of Attention]. *Zhurnal psikhologi pedologi i psykhotekhniki*, 1928, **1**, 138–149.
10. Ford, A., Attention-automatization: An Investigation of the Transitional Nature of Mind. *Amer. J. Psychol.*, 1929, **41**, 1–32.
11. Friedline, C. L., and Dallenbach, K. M., Distance from Point of Fixation *vs.* Intensity as a Determinant of Attention. *Amer. J. Psychol.*, 1929, **41**, 464–468.
12. Gamsa, M., and Salkind, A., Contribution à l'étude de quelques tests d'attention. *Arch. de psychol.*, 1929, **21**, 307–319.
13. Glanville, A. D., and Dallenbach, K. M., The Range of Attention. *Amer. J. Psychol.*, 1929, **41**, 207–236.
14. Gundlach, R., Rothschild, D. A., and Young, P. T., A Test and Analysis of "Set." *J. Exper. Psychol.*, 1927, **10**, 247–280.
15. Hovey, H. B., Effects of General Distraction on the Higher Thought Processes. *Amer. J. Psychol.*, 1928, **40**, 585–591.
16. Ilyinski, P., [On Concentration]. *Voprosy izucheniya i vospitaniya lichnosti*, 1927, **1**, 19–32.
17. Livshina, S., and Shriftsetzer, M., [The Collective Reaction of Concentration in Children of Pre-School Age]. *Ukrainski vestnik eksperimentalnoe pedagogiki i refleksologie*, 1927, **1**, 23–29.
18. Mandeville, S., La distraction. *Psychol. et vie*, 1928, **2**, 121–164.
19. Meisenheimer, J., Experimente im peripheren Sehen von Gestalten. Untersuchungen zur Lehre vom Sehfeld, von der Vorstellungsreproduktion und der Aufmerksamkeit. *Arch. f. d. ges. Psychol.*, 1929, **67**, 1–130.
20. Miles, C. C., and Terman, L. M., Sex Difference in the Association of Ideas. *Amer. J. Psychol.*, 1929, **41**, 174–178.

21. OPARINA, N. V., [Concentration by Children with a Disturbed Equilibrium of the Functions of the Central Nervous System]. *Voprosy izucheniya i vospitaniya lichnosti*, 1928, **2**, 20–27.
22. PHILIP, R., The Measurement of Attention. *Cath. Univ. Amer., Stud. Psychol. and Psychiat.*, 1929, **2** (No. 1), xi, 80.
23. PIÉRON, H., MME., Etalonnage d'un test d'attention: Le test de Toulouse et Piéron. *Bull. de l'instit. nat. d'orient. prof.*, 1929, **1**, 105–112.
24. PONZO, M., Significato e finalità di manifestazoni motorie in stati di attività psichica. *Arch. ital. di psicol.*, 1927, **6**, 1–39.
25. PRENGOWSKI, P., Le concept, le jugement et l'attention. Paris, 1929, pp. 103.
26. RODRIGUE, G., L'attention. *Psychol. et vie*, 1928, **2**, 86–87.
27. SEN GUPTA, N. N., Nature of Attention. *Indian J. Psychol.*, 1928, **3**, 157–167.
28. SKAGGS, E. B., Mr. Hovey on Distraction. *Amer. J. Psychol.*, 1929, **41**, 162–163.
29. TASSY, E., La provocation naturelle de l'attention. *Psychol. et vie*, 1929, **3**, 32–34.
30. TINKER, M. A., The Influence of Letter Position on range of Visual Apprehension: A Reply to Dr. Crosland. *Psychol. Bull.*, 1929, **26**, 611.
31. TINKER, M. A., ROBERTS, D., and JACKSON, H., Definite and Indefinite Preparation in the Visual Apprehension Experiment. *Amer. J. Psychol.*, 1930, **42**, 96–100.
32. VERWOERD, H. F., The Distribution of "Attention" and Its Testing. *J. Appl. Psychol.*, 1928, **12**, 495–510.
33. VERWOERD, H. F., Effects of Fatigue on the Distribution of Attention. *J. Appl. Psychol.*, 1928, **12**, 595–601.
34. WHEELER, R. H., Persistent Problems in Systematic Psychology. V. Attention and Association. *Psychol. Rev.*, 1928, **35**, 1–18.
35. WILCOCKS, R. W., The Effect of an Unexpected Heterogeneity on Attention. *J. Gen. Psychol.*, 1928, **1**, 266–319.
36. WOLF, A., Attention. Encyc. Brit. (14th ed.), 1929, **2**, 657–658.

MEMORY[1]

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I. Memorizing

The Curve of Memorizing. The form of the learning curve for motor skills, and the factors affecting it, have long been among the most active problems of the acquisition of skill. Upon the corresponding problems of memory,[3] however, comparatively little work has been done, although it is theoretically as important to know the temporal course of acquisition in one field as in the other. The reasons for the disproportionate emphasis upon the curve of skill to the neglect of that of memorizing are probably intrinsic to the techniques and materials of the two fields. The period of acquisition of most of the materials used in experiments upon memory is, for example, shorter than is that of most skills, and the plotting of a curve is a less obvious procedure. Further, a majority of the experiments upon memory are conducted by methods, now traditional, which do not yield a measure of progress at the end of each repetition, thus obviating the possibility of curve plotting. While these factors may account for the neglect of the curve of memorizing, they are scarcely more than historical accidents and certainly constitute no actual barrier to its study.

During the period covered by this review, but three titles refer with any directness to the curve of memorization. In an experiment by Foster (48) eight simple stories were read to pre-school children individually. At the first presentation each story was read through continuously. On nine succeeding readings the experimenter paused at certain definite places, about forty in each story, and waited for the subject to supply the words. While not all stories were given

[1] This review covers the period since the preceding review by the writer, "Memory," *Psychol. Bull.*, 1928, 25, 513–549, with the addition of a few titles for 1927. It includes experimental and theoretical papers, general treatments of memory, and reports of new apparatus and problems. Not all titles are mentioned in the body of the review.

[2] Research paper No. 177, Journal Series, University of Arkansas.

[3] The traditional distinction between the provinces of skill and memory is assumed for the purposes of this review.

under exactly the same conditions, no warping of results will occur by reporting composite curves. When words per child per story are plotted against repetitions, the curve for the group with a mean CA of 2–11 (years and months) shows a clear initial positive acceleration, those for age groups 3–4 and 3–8 present less positive acceleration, while that for age group 4–3 is almost linear. Likewise when the subjects are divided into groups with mean MAs of 3–2, 3–10, 4–6 and 5–8, the curves for the two lower groups are positively accelerated (that for the lowest MA group rises very slowly in a straight line, but it is fair to assume that it will turn sharply upward somewhere beyond the number of repetitions used, since the other curves show such a turn, though earlier), and those for the two higher are either linear or very little positively accelerated. The curves for the harder stories show more initial positive acceleration than do those for the easier. Markey (113) has reproduced several curves, for the acquisition by children of personal pronominal symbols, which show a pronounced initial positive acceleration, a characteristic which also appears in the scores of Martin and Fernberger (114) for improvement in memory span. The latter fact is particularly significant since only the best record of each day is included.

It seems likely that with memorial materials, as with motor skills, very young subjects, hard problems, and relatively low intellectual level are factors which produce a curve with an initial concavity to the *y* axis.

The Relation Between Length of Series and Difficulty. Thurstone (168) has tested, on well known data, two hypotheses regarding length of list and difficulty. According to Hypothesis I the relation between length and time should follow approximately the following law: $T = \frac{c}{k} n \sqrt{n-a}$, in which T is the total learning time, k is the learning constant of the subject, c is the criterion of learning (a constant), n is the number of items in the list, and a is the attention span of the subject. Since a virtually disappears in significance for long lists, the hypothesis states that learning time varies approximately as the 3/2 power of the length of the list. The equation given above has been fitted to some data from Binet and Henri, and to four sets of data from Lyon, and a very close agreement has been found between the theoretical curve and the experimental data.

According to Thurstone's Hypothesis II, the relation between the

number of repetitions and the number of items in the list should follow approximately the law, $R = \frac{c}{k}\sqrt{n-a}$, in which R is the number of repetitions and the remaining notation as in Hypothesis I. This equation has been fitted to the classical data of Ebbinghaus and of Meumann, and to data from Lyon. The theoretical curve fits well the data of Ebbinghaus for the longer lists, but only approximately those for lists of 7 and 12 syllables. It fits poorly Meumann's data, but with Lyon's the agreement between the theoretical equation and the experimental results is remarkably close.

Both hypotheses are limited to meaningless material learned by a single subject who has reached, before the experimental records are taken, a practice level for the material and method employed. Under these conditions the hypotheses that, save for short lists, learning time varies as the 3/2 power of the number of items, while number of repetitions varies as the square root of the number of items, yield a gratifyingly close agreement with experimental facts.

Skaggs (156) has suggested that the apparently discrepant conclusions of Ebbinghaus and of Meumann are both true within certain limits, and that the true relation between length and number of repetitions is an S-shaped curve. There is no contradiction between this suggestion and Thurstone's theoretical relationship, since the latter's equation takes account of very short lists by correcting for attention span. He also considers it probable that agreement with short lists near the span is not to be expected. In the curves obtained by Vogelsang (173) for the relation between number of items and the exposures required to learn them in varying arrangements, wide individual differences occur.

It seems to the writer that the results of Bills and Brown (9) upon quantitative set, while done entirely upon a problem in the field of work, have implications which cut across several of the problems of learning. It can hardly be doubted that memorization involves both work and acquisition, and that the latter masks any decrement which may be present. Bills and Brown find that the decrement varies directly as the amount of work with which the subject is faced at the start, *i.e.*, with his quantitative, 'amount' set. In learning it may well be expected that a subject's 'amount' set will correspond to the length of the list which he has before him to learn, and hence the longer the list the greater the relative decrement will be. Thus with long lists the decrement may operate as one of several factors to increase disproportionately the time required to learn, and with

short lists its lessened amount may weigh in producing the rapid learning thereof. It may be, as well, a factor to be considered in the part-whole issue upon which no paper has been published during the period of this review.

Distribution of Practice. One experiment dealing primarily with this well-worn problem has been published, together with several incidental confirmations of previously reported conclusions, and one review. Spight (160) has made an important comparison of the effect of two 12-hour rest periods introduced at the same stage in learning, one during the day and the other during the night, upon the learning of lists of 14 paired words. During the first sitting the material was presented until the subject was able to recall at least half of the items, and 12 hours later the learning was completed. The groups were equated in age, training and memorial ability, and the order in which the lists were learned was counterbalanced. The trials for the first half of the learning were almost identical for the two groups, but completion of the learning after 12 hours of which the major part was spent in sleep was significantly superior. Conditions were such that the difference must be a function of the filling of the interval. It is concluded that the greater ease of learning after the night interval is probably the result of physiological facilitation, since the memorial review which is at least possible during the day interval is ruled out. There is a second possibility, *viz.*, that during the night interval interpolated activities were minimal, with a resultant forgetting from retroactive inhibition which was less than that produced by the numerous interpolated activities of the day interval.

The general efficacy of distribution is confirmed by Jersild (90), who finds that two repetitions are more effective when an interval occurs between them than when they are presented in immediate succession; by Boring's (14) result that equal distribution of 12 repetitions over 3 days is better than 12 massed repetitions; and by Foster (48) who reports that 5 repetitions per day for 2 days are not as efficacious for the learning of stories by pre-school children as is distribution to the extent of one repetition per day. Vélinsky (171) finds that, where the intervals between successive presentations are not large, an increase in interval is accompanied by an increase in the number of presentations required for learning. Certain limitations upon distribution are implied by Ghosal's (54) conclusion that postponing fixation after meaning has been set up may be detrimental because of the concurrent weakening of meaning.

Ruch (147) has reviewed the literature on the optimal distribution of work and rest periods in relation to the various other factors affecting learning. His review includes studies of both memory and skill.

Age Differences. Now that the general increase in memorizing ability with increasing age has been established beyond cavil, research interests are being extended to include the course of the curve beyond the years of late adolescence. The highly significant work of Thorndike and his associates (167)[4] has shown that persons between the ages of twenty-five and forty-five are distinctly superior to children in learning ability and equal or superior to persons between fourteen and eighteen. The decline from the early twenties to the late forties is not more than from 13 to 15 per cent. The subjects were tested on representative materials, including a logical system (Esperanto) and school subjects. The decrease in learning which, on the average, is found to occur in the later ages may be ascribed to various combinations of the four factors, health and energy, opportunity, interest or motivation, and ability to learn.

The age curve for the recall of the symbols of the Army Beta digit-symbol test, used in Willoughby's (179) study of incidental learning, has a mode in the vicinity of age twenty-two and drops away sharply toward childhood and gradually toward old age. Jones, Conrad, and Horn (95) have constructed a composite curve for tests of the recall of the verbal and pictorial contents of motion pictures by persons, varying in age from ten to sixty, from 8 Vermont villages. Care was taken to render the form of the curve free from the influence of special selection within the communities involved, and from other extraneous factors such as visual acuity and interest in the pictures. Increase with age is virtually rectilinear to age fifteen, with negative acceleration from that point to age twenty-three. From forty-five to sixty there is a rectilinear decrease, and by age fifty-five performance has fallen below that for age thirteen.

Five studies corroborate the traditional results for the early years and one fails to do so. In Foster's (48) work on verbal memory for stories, the group of children with a mean CA of 4–3 start at a higher point and improve faster than the younger children; ages 3–4 and 3–8 are close together in performance; while the subjects of age 2–11 are clearly inferior to those at the higher ages. The older and more mature children are, however, more likely

[4] Reviewed at greater length in McGeoch, J. A., The Acquisition of Skill, *Psychol. Bull.*, 1929, 26, 457–498.

to remember the meaning of a passage and more apt to stray from exact verbatim reproduction. The correlation between CA and total score for verbal memory is 0.74 ($N = 22$). Barlow (3) has published curves which show a steady increase in number of syllables learned from Grade II to the college years, and McGeoch (119) finds that ability to report correctly in both the narrative and interrogatory forms increases slowly from age nine to age fourteen. Differences between successive age levels are small and are statistically unreliable, but they accumulate in such a fashion as to render the differences between the extremes of the age-range much larger and of a satisfactory degree of reliability. Narrative errors have no definite tendency to vary with age. Interrogatory errors decrease very slightly with increasing age.

According to Fischler and Ullert (46) memory span for digits and memory for geometrical figures increase very slowly, if at all, from age seven to adulthood; memory for words increases irregularly; and memory for pictures and for phrases show a clear age increase. The authors interpret the latter fact to mean that, with these materials, logical organization can enter, as opposed to the brute memory involved in digit-span and recognition of geometrical figures. They question the inclusion of the digit-span tests in the Binet-Simon scale, since the span presents so little clear increase with age. In all 530 subjects were employed and it is difficult to understand this divergence from the usual result unless the factor of interval operates against the influence of increasing age, which seems unlikely. Fischler and Ullert used a rate of two seconds per digit, which is much slower than the Stanford-Revision rate of slightly more than one digit per second. Young (181) obtains some increase with age in both forward and reverse spans. Learning span increases more definitely with age. Netschajeff (130) finds a steady and considerable increase in both digit-span and sentence-span between ages four and eight. In Garrett's (53) experiment, logical memory is the only test not negatively related to age in a group of 158 college men.

Sex Differences. The once eager search for fundamental intellectual differences between the sexes has noticeably abated, but conclusions regarding the relation between sex and mental functions continue to be reported, although they are for the most part incidental to other research interests. In the learning of lists of 20 syllables each, with full and restricted articulation, the girls excel the boys (Barlow, 3). The differences are not wholly reliable, but there is a probability in favor of feminine superiority. The total number

of cases is large. Ridgley (144) reports that, in an experiment aimed at studying children's interest in learning about places, the girls exceed the boys by 10.7 per cent in terms of the places actually looked up. McGeoch (119) has studied the problem of sex differences in testimony or report. Sex differences are found to be, in part, a function of the material upon which report is made. Reports upon the Binet object-card show no consistent sex differentiation, while reports on a picture, and even more on an event, show a somewhat consistent, though slight, tendency for the girls to excel. The differences are small and few are reliable. Assurance, measured by the per cent of items attested, does not vary regularly with sex. In recognition memory the women among Seward's (155) subjects have higher confidence ratings than the men. Recognition time has a greater range with the men; and there are no reliable differences between the sexes in mean speed or in relative variability of recognition times. In verbal memory for stories, the boys of Foster's (48) experiment consistently excel the girls, but the number of cases is small. Washburne's (174) experiment upon the use of questions in the learning of social science material reveals that girls are somewhat more affected by preview questions than are the boys, while with review questions the reverse is true.

Three other investigations yield no sex differences. The five immediate memory materials employed by Fischler and Ullert (46); the recall of incidentally learned symbols (Willoughby, 179); and learning both normally and under the influence of distraction from concurrent stimulation (Schorn, 149) fail to present such differences.

In studies on this problem one never knows whether the differences which appear, even granting their statistical validity, are inherent in the subjects or whether they are functions of the subjects' previous acquaintance with the material, and of other adventitious factors. Moreover, the reported differences uniformly fail of statistical reliability. It may safely be concluded that sex differences in memory, of whatever nature they may be, are very slight, probably inconsequentially so.

Intelligence and Memorizing. The far reaching implications, both theoretical and practical, of the problem of the relation between intelligence and memorial ability conspire to render it an increasingly active problem. Garrett (53) has conducted an extensive experiment, using 158 college men as subjects, in which he has correlated five tests of memory: visual and auditory digit-spans, visual and auditory paired-associates, and logical memory for fairly difficult prose; with

intelligence (Thorndike examination). The multiple correlation of intelligence with the five memory tests is 0.44, which becomes 0.52 when corrected for attenuation. The addition of three learning tests of the order of skill raises the corrected coefficient to 0.60. Individually the memory tests yield low correlations with intelligence. The multiple correlation coefficients are of no small significance because of the highly selected character of the group. The discovery of a substantial relationship between intelligence and memory records in comparatively routine tests, a relationship which would doubtless mount with the addition of more tests and finer measurements, points, Garrett thinks, to the essential oneness of intellect, a unity in terms of the Thorndikian quantity hypothesis, whereby simple connection-forming and high sagacity are basically the same. McGeoch (121) finds that the correlations of combined sigma standings on NIT and Army Alpha with correct narrative and interrogatory reports on the Binet object-card, a picture and an event are positive at every age from nine to fourteen and that most are high enough to indicate a definite relationship. With the two materials first mentioned, the interrogatory yields a higher correlation with intelligence than does the narrative. The height of the coefficient shows some tendency, also, to vary with the material upon which report is made. Total narrative errors are unrelated to intelligence, while total interrogatory errors are related negatively. Per cent of attestation is wholly unrelated to intelligence. In Hartmann's (71) study of precision and accuracy there appears a correlation of 0.05 between the Thorndike Intelligence Examination and interrogatory reports on pictures. Cushing's (36) conclusion that perseveration depends more upon mental age than upon chronological maturity has important implications for memory problems.

The relation between MA and the form of the curve of memorization for words in stories has already been discussed (Foster, 48). When pre-school children are divided into groups with mean MAs of 3–2, 3–10, 4–6, and 5–8, the curves for the acquisition of words by each group run at a level corresponding to the MAs of the group. A fairly high correlation appears (Hegge, 73) between mental level and answers to questions upon a simple story by a group of subnormal children. Above an MA of 5.3 no total failures occurred. Farson (44) obtains evidence of a positive relation between memory span performance and school success, and Willoughby (179) reports a correlation of 0.686 between school grade and the recall of incidentally learned symbols. Such recall correlated but 0.133 with

brightness. Anderson and Jordan (1) present a correlation of 0.65 between I.Q. and immediate memory, and Lowery (109) has published a coefficient of 0.44 between the Tomlinson 'West Riding' tests of mental ability and musical memory. Schorn (149) finds a rough positive relation between immediate memory for an event, enacted while the subjects worked at arithmetic sheets, and scholastic ability. Intelligence seems to be a differentiating factor with respect to the optimum method of acquiring academic material (Greene, 62). Students whose Thorndike Intelligence Examination scores, or whose college grades, fall in the upper quartile of the subjects used, tend to learn slightly better by reading the material for themselves than from lectures. The opposite is true for the lowest quarter of the students. Independent learning (Herrmann, 76) corresponds somewhat more highly with estimated intelligence than does ordinary school learning.

It will have been noted that the relationships between intelligence and memory which have been summarized, in common with those previously reviewed, are uniformly positive and consistently low. The substantial multiple correlation obtained by Garrett between five memory tests and one of the best existing measures of intellect would, however, lead one to suspect that the small relationship between single measures of memorial function and single intelligence tests are but the outcome of numerous factors specific to the experimental conditions, and that a composite of a very large number of variously obtained records of memorial ability would approach as a limit that which is measured by tests of general mental ability.

Sensory Modality and Method of Presentation. Sensory modality and the methods of presenting learning materials are variables which are closely interrelated, and the experiments upon the two will be reviewed together. Tilton and Knowlton (169) have made a well-controlled attempt to measure the contribution of ten chronicles-of-America photoplays to history teaching in the seventh grade. Under the influence of the photoplays the experimental group gained 19 per cent more than the control. To show in another way the significance of this gain, a control group was selected of sufficiently greater ability to permit it to make the same amount of gain as the experimental group. This control group was, on the average, brighter, over a year more mature mentally, and one grade farther advanced in knowledge than the experimental group. The gain of the experimental group did not take place at the expense of standardized progress. The photoplays were most effective in teaching about the interaction of

forces and events, historical personages and geography. They interfered somewhat with the learning of time relationships.

Three methods of presentation have been employed by Russell (**148**) with groups equated in intelligence. By one method the material was read twice to the class; by a second the students were to read the material at their normal rates over a period equal to that consumed by the teacher's reading to the first group; and by a third the pupils were to read the material twice at a normal rate, regardless of absolute time. Learning was tested by essay and true-false questions. With Grade V the teacher's reading was best and the pupils' reading with time constant was worst. In Grade VII the methods were roughly equal; and in Grade IX the teacher's reading was worst and the pupils' reading with frequency constant was best. The differences in the two higher grades are very small, however.

The lecture (auditory) and reading (visual) methods of presentation are equally effective in the acquisition of the content of psychology (Greene, **62**). The fact that the high quartile in both intelligence and grades did slightly better with the reading method and the low quartile with the lecture method has already been noted. In learning Latin (Fenton and Hill, **45**) the reinforcement of the book's presentation by pictures to illustrate the words proves beneficial; and in learning meaningful materials (Ewald, **43**) the subjects who employed visual grouping did better than those who used an auditory grouping. Gudeff (**65**) discusses briefly certain physiological and anatomical aspects of the visual and auditory modalities and their relations to memory.

In interpreting such experiments one must remember that the influence of sensory modality becomes, under most experimental conditions, a problem in the method of presentation of the material, since presentation to a given receptor by no means insures that learning will go on primarily in terms of that modality. The subject may translate the material into any terms he is able to use.

The Grouping of the Material. The work presented under this topic is correlative with that discussed under the foregoing heading. The experiments there discussed were concerned with the objective presentation of the material to the subject by the experimenter; those here reviewed have to do with the units in which the subject handles the presented materials. Ewald (**43**) has attacked at some length the problem of the size of the groups or 'complexes' with which subjects can deal effectively in learning both nonsense syllables and meaningful material. Wide individual differences appear. Some

subjects, for example, can manage only 4 syllables as a unit; others, the best, can manage as many as 8. The best learners of both materials are those who apply grouping methods, who are 'complex-strong'; the poor learners are weak in ability to group. The size of the units which can be handled varies also with the nature of the material. Vogelsang's (173) better subjects were, likewise, able to deal with larger groups than were the poorer ones. The introspective data of an experiment by Martin and Fernberger (114) on improvement in memory span show that the improvement occurs at the level of organization into groups. The subjects experienced difficulty in handling groups containing more than five items.

Mnemonic Devices. Intimately related to the last section is the matter of mnemonic techniques. Belanner (7) publishes a graphic representation of his own visual number-form with cases illustrating its use in recalling numbers and dates. Spielrein (159) was able to duplicate, by organization into a pattern, the feat of a 'memory-artist' who could repeat a long list of words heard but once. He describes the difficulties and characteristics of such organization. Hegge (72) has called in question Spielrein's interpretation of certain of his illustrations, but agrees upon the importance of meaningful connection. Hosiasson (80) calls attention to the mnemonic value of classifying material to be learned and of associating it with one's already acquired experience.

Phenomenal Memorizing. The period's crop of phenomenal memorizers is hardly as luxuriant as was the one harvested in 1928, but they are still with us. Jaensch and Mehmel (86) describe an imbecile boy of eighteen who by use of eidetic imagery could give, with a mean reaction time of 7.8 sec., the day of the week of any date mentioned between 1920 and 1927. He can do the same for other years if the questioner will tell him the day of the week of any one date of the year in question. He gets the calendar for the entire year in eidetic imagery; no calculating is required. A case is reportd by Phillips (134) of a low grade imbecile boy with specific memorial ability for words and tunes. Löser (108) records the case of a pupil with unusual visual memory for digits and words, an ability far in excess of the rating of his other associative processes. The man described by Friedländer (50) is possessed of a poorly integrated personality, but is able to repeat *in toto* the contents of the Sunday edition of a large newspaper which he has read but once. He is able to do likewise with speeches, repeating not only the words but the gestures and mannerisms of the speakers. The unusual

memory of the lightning calculator of whom Blachowski (10) writes is also in point. The use of essentially the same mnemonic devices as those described above appears in most of these cases.

The Influence of Attitude or Set. Jersild (89) raises the question of the influence of the mental activity aroused by a preëxamination upon subsequent learning. In five different experiments subjects were examined upon materials new to them and then reëxamined after a period of study. Equivalent controls were not preëxamined. The use of multiple-choice and essay questions for preëxamination resulted in consistently higher scores for the preexamined group. True-false tests were either ineffective or detrimental. In so far as preëxamination arouses an activity attitude and stimulates industry it is beneficial. Analogous to these conclusions is that of Washburne (174) concerning the greater efficacy of questions placed at the beginning of a story than of those placed at the end. His results, also, are to be interpreted in terms of the set aroused by the questions.

Maso (115) compares the influence of active and passive attitudes upon learning. In one experiment, under the active attitude, the subjects were to sort pictures accompanied by their names into three designated classes; under the passive attitude they were given the pictures already sorted and were told to look at them attentively. In other experiments the memorial values of matching names and objects, attributes and objects, and looking up specified biographical information were compared with the corresponding values when the materials were presented already matched or gathered. The precise nature and extent of the active attitude and the amount of its differentiation from the so-called passive attitude are unknown, but the two attitudes yield somewhat different results. For a majority of the subjects the active attitude is the better. The differences between the two are much larger on delayed than on immediate recall.

The problem studied by these three investigators is one which cuts across a large proportion of the other problems of memorizing and retaining, and overlaps, as do many such, the fields of thought and reasoning. The investigations of the effect of attitude have clearly indicated that learning alters with change of set. The quantification of set and the measurement of its influence along a qualitatively uniform continuum is a highly important problem of the future.

Memory Span Studies. Martin and Fernberger (114) report a rather marked improvement in auditory memory span following

continued practice. One subject improved 47 per cent, the other 36 per cent. The authors are careful to point out that interpretation of these results must be guarded. The span which is improved is that obtained by grouping and gains are based on the development of better methods. If, on the other hand, one means by memory span the range of items which can be reproduced after a single, ungrouped act of attention, the span is little, if at all, susceptible to improvement through practice. Martin and Fernberger gave their adult subjects two series daily for each number of digits from five until the span broke down. Young (181) has employed a somewhat different technique with subjects varying in age from 4–0 to 10–11. When the subject failed three forward auditory digit-spans at a given length, a series of that length was repeated to him until he had mastered it or had made ten failures. The subjects were taken as far as they could go before making the criterial number of failures. The average learning span was less than one digit beyond the immediate memory span. Thirty-eight per cent of the cases were incapable of learning beyond their digit-spans, 50 per cent attained a learning span of one digit greater, 11 per cent of two digits greater, and a few cases did still better. Revised norms for memory spans for digits, syllables and ideas have been published by Gillespie and Brotemarkle (56). Brooke (19) has compared the auditory and visual memory spans of clinical and institutional cases and has concluded that the latter are inferior.

Serial Position. Foucault (49) proposes to examine two different kinds of inhibition which appear within a memorized series: regressive internal inhibition, which is similar to retroactive inhibition save that the inhibiting factors arise within the series itself, and progressive internal inhibition, which refers to the detrimental influence of the earlier items of a series upon the later ones (proactive inhibition). He reasons that, as lists of words, once presented, are increased in length from 3 to 7, regressive inhibition will show itself in a lessened number of correct recitations of the initial item, then of the second item and so on, while progressive inhibition will have a similar effect on the last items. When adults are used as subjects, he obtains no very consistent results, but when 100 children are employed, clear serial position curves of the customary type, and of the kind required by Foucault's assumptions, appear. If the two kinds of inhibition work additively, the 4th word in a 7-word list should suffer the sum of the forgettings of the first and last words of the list, here 21. Actually its forgetting score is 81. Thus the

combined action of the two factors is greater than their sum. He explains this by assuming that succeeding words are weakened by progressive inhibition and are thus unable to resist regressive inhibition. In the middle of a list this condition obtains most strongly. Foucault's experiment is of the usual serial position kind, but his interpretations, which are the same as those previously made in outline by Woodworth and Poffenberger (1920), are important. They fit the obtained facts with some exactness and constitute an internally coherent explanation in terms of already familiar concepts. If we grant the validity of this hypothesis, the advantage of primacy is explained by freedom from progressive inhibition and of finality by freedom from regressive inhibition. In most of his series, as in the results of Robinson and Brown (1926), for example, primacy is superior to finality. It should be noted, however, that there are other factors as well as inhibition which may enter into the production of serial position values, such as positive association with position, a possible review, and a 'set' toward certain parts of the list, notably the first and last. In their study of associative blocking, Elkine and Krasnopolsky (42) find a progressively diminishing effect as the member common to two successive lists is displaced toward the middle and end of the series. They explain this in terms of the basically forward direction of associations.

The four factors, primacy, recency, frequency and vividness have been carefully examined by Jersild (88, 90). The material consisted of 70 narrative statements composing the biography of a fictitious person. Rotation of statements served to counterbalance differences in memory-value between the statements themselves, and each score for a statement under the influence of an experimental factor was calculated in terms of the scores for that statement when placed in the middle of the exercise and not subjected to any experimental device. Primacy (first position) has a high value, which is exceeded only by a frequency of 3, 4 and 5 repetitions and by one vividness factor. The second and third positions also have some advantage. Primacy is much superior to recency, regardless of what degree of each is compared. Willoughby's (179) data support the superiority of primacy and finality and confirm the current conclusions regarding serial position.

Frequency and Vividness. In Jersild's (88, 90) comparison of several factors of advantage, or modes of emphasis, in the learning of a biography spoken by experimenter to subjects, frequency and several devices to provide vividness were employed as well as the

conditions of primacy and finality. The nature and value of each may be shown most compactly by listing them in order of rank from best to worst in terms of percentage score: 5, 4 and 3 repetitions; " now get this "; primacy; 2 distributed repetitions, positions 11–60; second position; 2 distributed repetitions, positions 35–40; " Did you notice that? "; pause; 2 concentrated repetitions, positions 60–60; third position; recency, last position; loud; third from last statement; second from last statement; gesture; 2 concentrated repetitions, positions 10–10; bang; middle or normal; and slow. The range of percentage score is from 315 to 79. It will be noticed that the vividness devices tend to come toward the middle and lower end of the rankings, the frequency and primacy factors toward the upper end. In point is Willoughby's (179) low but significant correlation between recall and amount of practice upon the associations recalled.

The Results of Continued Memorizing; and Transfer. After preliminary practice, Heron (74) presented successively two separate lists of 6 paired syllables to large numbers of subjects under three conditions of relation between the members of the two lists: (A) all syllables different; (B) first and last pairs of the second list containing a syllable found also in the first list, and (C) the first members of the first, second, fifth and sixth pairs being syllables found in the first list. The conditions were presented in counterbalanced practice order. The second list was learned uniformly with fewer trials and fewer errors than the first list, and these differences were statistically reliable. This is viewed as a warming-up effect or a positive transfer lasting over only a short period. It had disappeared after an interval of one week. This disappearance, and the fact that practice effects and differences in the difficulty of the lists are cancelled out, are taken to validate the warming-up effect and to distinguish it from a transfer of specific habit-units. Elkine and Krasnopolsky (42) obtain small but consistent practice effects from the learning of four different and successive lists of 10 numbers each. When the first members of two lists are the same, difficulty of learning the second list is somewhat increased. Within limits an increase in the number of common members increases the degree of associative blocking. This blocking or negative transfer is less strong in ' mechanical ' than in associative or logical memory. Brinkmann (18) attacks by new methods the old *Aussage*-problem of the trainability of observation and report. He uses the search method of Ach and concludes that such abilities can be improved by training. One good device is practice at observations which increase progressively in

difficulty. The most important condition for good performance is a suitable determination.

Orata (133) attempts a critical analysis of Thorndike's theory of identical elements. He first reviews numerous experiments on transfer of training and concludes that Thorndike's theory of identical elements is, for several reasons, invalid. (A) It is not supported by reliable experimental evidence; (B) logically, to say that transfer occurs in terms of identical elements is but to say that it does occur; (C) the theory rests upon a specialized, atomistic view of mind; and (D) it is incompatible with sound educational theory. Transfer takes place, his analysis of the literature is taken to reveal, "to the extent in which conditions favorable to transfer are present," which is scarcely enlightening. He proposes to reinterpret the problem in terms of a different theory of mind. Transfer is defined as "the extension and application of meanings to new problems or situations in such a way that we can deal with them effectively." Amount thereof "depends upon the extent to which meanings are identified and applied," and is "facilitated by concept formation." It is not possible to examine here Orata's interpretation of the experimental evidence. It is made, however, against the background of a theory of mind which is briefly presented, to defend which no systematic attempt is made, and in which appear many crucial items which are but categorically stated. The evidence against a narrowly specialized and atomistic view of mental functions may be convincing, but a more systematic work is needed to render acceptable the reinterpretation given, although it should be said, in fairness, that it contains many important comments upon the problem.

Correlations Between Different Materials. The important investigation by Garrett (53), whose conclusions regarding the relation between intelligence and memory have already been reviewed, involved computations of the intercorrelations between the memory and learning tests employed. The coefficients were for the most part low, around 0.21 as a central tendency, but when the proper statistical technique was employed, it was found that there was a common memory factor present which "is represented by an average intercorrelation which is almost certainly as large as .11 and may be as large as .17." Fischler and Ullert (46) have intercorrelated the performance of a large group of subjects on immediate memory for phrases, words, pictures, digits and geometric figures. The correlations, as were Garrett's, are low; and some are negative. Scrutiny of the tables of the two papers yields the tentative suggestion that the tests

which are most alike in form, in content, or in both, yield the highest intercorrelations.

In McFarland's (117) study of the relationship between speed and mental ability, the correlations between memory for serial impressions and other tests run in decreasing order from an *r.* of 0.77 to one of 0.10, as follows: insight, maze running, form board, sentence completion, simple reaction, opposites, synonyms, discrimination and number sense. Every *r.* save the last is 0.40 or better. In the complexity-of-task ranking, memory is well toward the top. Netschajeff (130) likewise reports high correlations between digit-span, sentence-span and six non-memory tests, as well as one of 0.66 between the two spans.

Low correlations have been found by Hartmann (71) to obtain between memory for words, reports on pictures and tests of perseveration. The learning of meaningful material (Ewald, 43) involves abilities different from those required in learning nonsense syllables. The subjects who did best with the latter did not excel with the former where, instead, the average learners of syllables did best. McGeoch (120) has intercorrelated the narrative and interrogatory report scores upon three different materials, the Binet object-card, a picture and an event. The average correlations between narrative and interrogatory score varies between 0.230 and 0.428 for correct items and between 0.095 and 0.203 for wrong items. When the same methods of reporting upon different materials are intercorrelated, the *r.*s range from 0.076 to 0.431, the size of the *r.* being a function of the materials, scores and methods of reporting. It is concluded that the ability to report is a function specific to the several factors involved.

The Reliability of Experimental Materials. No paper devoted specifically to a determination of the reliability of the materials used in work on memory has appeared, but reliability coefficients have been published, somewhat incidentally, by Garrett (53) and by Hartmann (71). Garrett's coefficients are as follows: visual and auditory digit-spans, 0.68 and 0.80; visual and auditory paired-associates, 0.95 and 0.90; logical memory, 0.60. Hartmann's are: recognition memory for words, 0.58, and report on pictures, 0.22. Garrett has also correlated the sum of eight memory-learning tests with the sum of eight identical tests, obtaining a result which is approximately 0.93. In general it seems that the reliability of some at least of the materials for experimentation on memory is higher than is that of the stylus maze, for example, in the field of skill.

Methods, Apparatus and Materials. Robinson (145) has published a classification and evaluation of the methods of practice equilibration. The method of completed practice is seldom used because, *e.g.,* the limit of practice is so often beyond experimental reach. There are three methods of uncompleted practice: (A) the method of predicted learning, which is usable when the experimental condition is known to work against the practice effect; (B) the method of the control group, which requires that N be large; and (C) the methods of counterbalanced order, which assume relative linearity and that the groups will be equally influenced by a given amount of practice, and which is trustworthy if several cycles yield consistent results.

Chou (27) contributes a useful bibliography and classification of exposure apparatus. He suggests the term *bradyscope,* first used by Esper, for all exposure devices used in work on memory, in contrast to the term *tachistoscope,* which is reserved for apparatus with very rapid exposure rates. He describes a new quadrant tachistoscope which can also be used as a bradyscope. An account of an automatic card feeder and catcher mechanism to go with this has recently appeared (Chou, 28). The use of a moving picture projector as a demonstration apparatus is recommended by Pillsbury (136). Its cost of operation is negligible and it can handle a wide range of materials.

Glaze (57) has made a valuable experimental classification of 2,019 nonsense syllables in terms of their associative values. Each syllable was exposed to each of 15 subjects for 3 sec. in a tachistoscope, the subjects having been instructed to indicate what meaning, if any, the syllable had for them. If all subjects gave a response word to a syllable, it was placed in the 100 per cent division with regard to associative value; if no subject had an association with a given syllable, it was given a rating of 00 per cent; and so on for each proportion of the 15 subjects for whom a syllable had associative value. The classified syllables are published in full. Glaze does not claim that all of the syllables have the exact associative value assigned, but only that those in the lower ranges are actually low and are numerous enough for most experimental purposes. The value assigned to a particular syllable is doubtless a function of the experimental conditions employed by Glaze, but his work is an important step in the calibration of experimental materials.

Boring (14) reports the character of, and some typical results from, certain demonstrational experiments in memory which he has

used for a number of years and which yield results illustrative of the facts about length of list, distribution, and meaningful vs. nonsense material, together with qualitative observations. Awaji (2) describes an immediate memory test consisting of pictures. Learning is tested by a modified form of recognition.

Applications of Data on Memory. For an experimental group, teaching situations which applied some of the principles of the psychology of learning were chosen by Laton (104), and this group was compared with a control in the teaching of which no conscious applications of psychology were made. The experimental group acquired more knowledge than the control by several methods of testing. Sell (151) includes extensive tests of memory and of observation in his inventory of the personality traits of a normal twelve-year-old child; and Netschajeff (129) has used memory performance as one factor in a coefficient to determine the extent of the harmonious relation between sensory and motor functions.

Miscellaneous. Under this head will be reviewed topics upon which only a single paper has been published, or upon which very briefly statable results have been obtained. (A) *The Rôle of Articulation.* Three hundred and twenty-seven subjects, grade and college students, learned 20-word lists under a verbalization condition, in which they were instructed to repeat the words by use of tongue and lips, and under a restricted articulation condition, in which they were instructed not to say the words. They were assisted in the restriction by a pencil held crosswise between the teeth. The averages consistently favor the learning under unrestricted articulation. Barlow (3) interprets his results in terms of a dynamic influence of articulation upon learning mechanisms.

(B) *The Memory Value of Absolute Size.* Newhall and Heim (131) report that the immediate recall value of advertisements is independent of their absolute magnitude. Three absolute sizes, 50, 100 and 150 square inches, were employed with large groups of subjects and adequate experimental conditions. (C) *The Influence of Exposure Time.* Newhall and Heim, in the above experiment, used exposure times of 2, 5 and 15 seconds, with the result that immediate recall increases considerably with each increase in exposure time. Elkin's (41) conclusion that number of presentations required varies inversely as the speed of presentation is concordant. (D) *Rhythm.* Elkin finds, also, that the more the rhythm of the presentation of lists of numbers and of nonsense syllables is broken,

the larger is the number of repetitions required for learning. (E) *Independent Learning.* Fourteen-year-old boys are able independently to comprehend and assimilate ordinary school material for themselves. They have, as well, good insight into their own learning methods (Herrmann, 76).

(F) *The Mnemonic Independence of Form and Color.* Pialat (135) has raised this question and has investigated it by means of nonsense words paired with variously colored forms. The relative importance of the two factors is a function of the experimental conditions, but under the normal conditions employed color plays a rôle secondary to that of form. (G) *Memory for Onomatopes.* With pupils of the fifth and sixth grades and with college students, onomatopes have less advantage in immediate memory than concrete words and more than abstract words, when each is read in lists of discrete words to subjects covering a wide range of intellectual ability (Stoke, 164). (H) *The Direction of Association.* Stoddard (163) had 328 subjects learn and recall immediately lists of 50 paired French and English words under various conditions of direction of association. With learning order disregarded, the ratio of equivalents for French words recalled to equivalents for English words recalled is two to one; regardless of the order of learning, the unfamiliar French calls up more correct associations than the familiar English.

(I) *The Influence of Alcohol.* According to Kurka (102), alcohol in varying amounts increases the number of errors and the variability of records in the learning of nonsense syllables. (J) *Neural Conditions of Acquisition.* De Mortier (127) discusses the neurological conditions of amnesia of fixation and concludes that bilateral destruction of the prefrontal areas in man produces such amnesia. For mnemic acquisition, also, the paths from the prefrontal to the posterior cortical areas must be intact. (K) *Memory of Pronunciation in Aphasia.* Noica (132) states that motor aphasia is especially characterized by a loss of memory for pronunciation of words. Loss of power of evocation also occurs. (L) *Imagery in Memorizing.* Garfunkel (52) has examined the relation between eidetic imagery and immediate memory for sentences auditorily presented, and finds no uniform relation. The memory performance of a feebleminded boy with eidetic memory has already been mentioned (Jaensch and Mehmel, 86). Forsberg (47) stresses the importance of the relation between image-type and the material to be learned. (M) *Motivation to Study.* One of the major conclusions of Craw-

ford's (32) excellent survey of student opinion and activity is that motivation, appreciable purpose, is one of the major factors in the academic learning of students. A discussion of motivating factors is given.

(N) *The Influence of Information on Memory for Pictures.* Droba (40) has made an interesting experimental analysis of the effect of varying amounts of information about pictures of paintings in the Art Institute upon their recall. Some information is better than none, and the efficacy thereof varies with the amount and the exposure time. In general the information most favorable to recall is the name of the picture, the last name of the painter, and a short sentence about him. (O) *Attention and Memorizing.* Schorn (149) finds that children report much less well when the material was received simultaneously with the occurrence of another activity than when it is presented alone. Divided attention, presumably, is deleterious. With this the work of Sterzinger (162) agrees. Meyer (126) has shown that total attention is superior for formal and quantitative relations, while discrete attention is better on the qualitative side. Sengupta and Bose (154) emphasize the importance of definitely directed, as opposed to indefinitely directed, attention. Wide individual differences appear in the influence of distraction upon the learning of nonsense syllables (Weber, 175). (P) *Racial Differences.* According to Graham (60) whites are superior to negroes in rational learning. Gray and Bingham (61) conclude that white children are superior to colored in musical memory by the Seashore Test. There is, however, likelihood that the superior intelligence of the whites is a major factor in both of these cases, as in Lightfoot's (106) finding that colored children have short memory spans. Netschajeff (130) finds small memorial differences between children of five different nationalities.

II. Retention

It is interesting, though scarcely gratifying, that there has been for years a clean-cut selection in research upon retention in favor of memory problems. Within the general field of memory, retention has been studied almost, if not quite, as systematically as has memorization; while in the field of skill, on the other hand, very little systematic work has been done upon retention. The reasons lie embedded in the history of research upon learning. They can hardly be examined here, but the facts are deserving of comment.

The Curve of Retention. Bassett (4, 6) has made an extensive

study of the retention of history in the 6th, 7th, and 8th grades. Carefully constructed tests were given at 4-month intervals after the completion of a given course. The retention curves, which run from 0 to 16 months, show the usual negatively accelerated form, but the absolute amounts of forgetting are much less than those of the classical studies of the foregetting of nonsense syllables and other disconnected material. After 16 months an average of only 28 per cent of the material had been lost. Interpretation of these results must take into consideration the fact that the tests were given to the same subjects after each interval and that during the meantime these subjects had been studying other courses in history with the resultant inhibition or facilitation which may have followed such study. Bassett's data, however, represent well the facts for actual school conditions. Great care has been taken to render the material representative and trustworthy for these conditions. Another and similar investigation by Brooks and Bassett (20) with junior high school pupils yielded the same negatively accelerated retention curve and the same small absolute amounts of forgetting. In a year's time, *e.g.*, 23 per cent of the American history known at the close of the semester during which it was studied had been forgotten. Johnson (93) has computed the percentages of retention of elementary botany over periods of 3, 6 and 9 months and, by a less accurate method, after 15 and 27 months. The negatively accelerated curve form appears, but the absolute amounts of forgetting are much larger than those obtained by Bassett and by Brooks and Bassett. The difference, over and above that intrinsic to the difference between the materials, may be explicable in terms of the fewer subjects and the less exactly comparable and exhaustive retests available to Johnson. In a preliminary report, Worcester (180) describes an experiment designed to measure the retention of high school algebra. The initial results indicate high retention.

Whitely and McGeoch (177) obtain a curve of retention for poetry which falls abruptly from immediate recall to recall after 30 days and very gradually from that point to 120 days. The drop from 30 to 90 days is insignificant. After 120 days 28 per cent of the amount originally recalled is still retained. Anderson and Jordan (1) have plotted retention curves for Latin words (paired-associates) and phrases. Retests were made after one day, one, three and eight weeks. After one day the Latin stimulus words were given in the order in which learned; on later recalls they were presented in a changed order. Retention of words falls off irregularly from an im-

mediate recall of 74 per cent to one of 54 per cent after 8 weeks. Phrases fall correspondingly from 60 to 50 per cent. The negatively accelerated curve form holds throughout. Krueger's (101) recall and saving records for the retention of lists of 12 monosyllabic nouns after 1, 2, 4, 7, 14 and 28 days present the customary negative acceleration, but the amount of forgetting and the sharpness of the deceleration vary inversely as the degree of learning. Griolet (63, 64) attempts to show that forgetting is proportional to a root of the elapsed time. The particular index is dictated by the experimental conditions.

There have been few reported cases of reminiscence, the striking inversion of the usual retention curves which Ballard made famous. Some evidence of the phenomenon has been obtained by Foster (48) who counted the number of words given on the first relearning repetition of stories but never given on any learning repetition. Individual differences appeared: a few subjects gave no new words, others gave many, one averaging 20.8. Bloor (12) is inclined to ascribe the reminiscence effect to subconscious activity, an explanation which must needs be given further systematic elaboration to be significant.

The Influence of Interpolated Activity. The blocking of measurable retention by interpolated activities has far-reaching implications for the understanding of forgetting, and one of the most urgent problems of this blocking effect is that of the influence of the similarity obtaining between the original and the interpolated activities upon the amount of the inhibition. This has been studied by Harden (70) and by Cheng (26). The former takes her problem from the failure of Robinson's (1927) results to conform to the hypothetical Skaggs-Robinson relation between similarity and degree of retroactive inhibition. This failure may have been due to the fact that Robinson employed consonants (similar materials) in both halves of his 8-member memory spans, at the same time varying degree of identity. While this method carries degree of similarity from identity downwards, it does not reach farther than something like a median degree, even with no consonant in common, because of the identity of the type of the material. Harden proposes to use consonants in the first half of the span and in the second a number of digits corresponding inversely to the degree of similarity desired, thus introducing non-identity of items and dissimilarity of material into the second half of the span. Thus in her experiment the greatest similarity between the two halves is attained by using dif-

ferent consonants in both, and the least similarity by using four digits in the second half. In the three intermediate degrees one, two and three digits are used. The factors of order, position and practice are controlled. The conditions of presentation are different from those of Robinson, but the implications of the results are perhaps little affected by this difference. The percentage of correct recall declines from four items in common to one item in common and mounts sharply when there is no common item (assigned zero similarity). When the Robinson-Harden data are combined, a curve resembling in form the hypothetical relation appears save for the difference that the right section of the curve mounts sharply instead of flattening out.

Cheng has approached in two experiments the problem of the influence of similarity, using nonsense syllables as both original and interpolated material and achieving three degrees of similarity by having the interpolated syllables related to the original syllables of corresponding position to the extent of no common letters and one and two letters in common. In the first experiment the intra-syllable position of the common letters was varied to cover all positions. In the second experiment only certain intra-syllable positions were used. All interpolated conditions produced some retroactive inhibition, the degree of which varied with the experiment and with the method of measuring retention. Measured in terms of recall, retroaction at first increases and then decreases as degree of similarity increases from zero to two identical letters, while in terms of saving retroaction exhibits only a very slight tendency to decrease with increase in similarity. In the first experiment identity of the vowel had less retroactive effect than did identity of either consonant, and identity of the first and last letters had less effect than did identity of the two first or the two last, which are about equal in effect.

The evidence in favor of similarity as one of the conditions of retroaction is accumulating, as is support for the general correctness of the Skaggs-Robinson hypothetical curve under certain specified conditions. The experimental work of the last few years has carried the problem well beyond the speculations of the early investigations, but we are still far from the point at which a satisfactory generalization can be made. Experimenters have worked, perforce, with narrowly specified kinds of similarity in arbitrarily defined degrees. In the work reviewed, for example, Cheng has kept within the circle of identical letters in 3-letter syllables, that is, within a narrow range of formal identity. Harden, extending Robinson's technique,

has retained a certain kind of formal identity but has moved beyond a single continuum of material, and has thereby raised puzzling theoretical questions. She would designate the series BLFP7469, *e.g.*, as one in which the similarity between the two halves of the span is zero, and the series BLFPXCJD as one of maximum similarity because of the continuity of the type of material. Actually, of course, the quantitative relation between the two degrees of similarity is unknown, and to plot similarity thus defined in the same continuum of material, though really passing in the middle from one continuum to another, is an arbitrary procedure. Harden is, of course, aware of this fact and can appeal to the rational extension of the Robinson curve which her results provide. It is both remarkable and important that so clear a continuity of results emerges from so arbitrary a definition of similarity, and further explorations of other kinds and degrees of similarity may permit eventually a generalization.

Jenkins and Dallenbach published in 1924 the results of an important inquiry into the relative amounts of forgetting after sleep and after waking. Forgetting after sleep was much less with all intervals and decreased as the intervals lengthened from 1 to 8 hours. This fact points to the interpolated activity of the waking hours as a blocking factor. Dahl (37) has repeated the Jenkins and Dallenbach experiment with 14 subjects, using 12-item lists of nonsense syllables and of figures and testing retention by the recognition method. The sleep condition is consistently better when only errors in the form of failures to recognize are considered; it is superior only after 4 and 8 hours (not after 1 and 2) when errors in the form of recognizing new material falsely, and total errors, are counted. The facts corroborate, in the main, the results of Jenkins and Dallenbach, but Dahl refuses to interpret poorer recall after waking as a case of retroactive inhibition. He thinks that the results say nothing about what happened to the material *during* sleep or *during* waking, but are rather a function of the subject's condition at the time of recall. After one and two hours of sleep the subjects were very sleepy and in no condition to recognize clearly, hence they did somewhat worse (in that they wrongly recognized confusion materials) than after waking. After longer periods of sleep they were in better condition and did better than after corresponding periods of waking. That there was some difference in the subject's condition after the different intervals is taken to be indicated by the fact that the tendency to give more 'yes' answers after sleep than after waking was much greater after 1 and 2 than after 4 and 8 hours.

If we consider only Dahl's results, there is no way of adjudicating the retroaction vs. condition-at-the-time-of-measurement issue. When, however, it is remembered that the Jenkins and Dallenbach subjects would, when awakened by the experimenter, go to the next room, recall in a very sleepy condition, return to bed, and be unable to remember anything of the experience the next morning, it seems hardly likely that there was a greater 'fitness' for recall after the sleep intervals. These subjects recalled, also, under a more exacting method than did Dahl's. Spight's (**160**) evidence for more effective completion of learning after a period, the major part of which was spent in sleep, than after an equal period of waking, agrees factually with the findings both of Dahl and Jenkins and of Dallenbach. Since her subjects did not resume the learning until some time after waking, the results can not be interpreted as the outcome of any immediate condition attendant upon being awakened, although the general fitness may have been greater. The considerations mentioned above, together with the coherence of these facts with those concerning inhibition, create a presupposition in favor of the interpretation of the better retention after sleep as an outcome of decreased blocking by interpolated activity.

McGeoch (**122**) has studied the extent to which retroactive inhibition is a function of the degree of learning of the interpolated material. Nine-syllable lists were learned by the anticipation method to 6, 11, 16, 21 and 26 repetitions, and a constant interpolation of 11 repetitions of a list of equal length was used. In terms of recall, the relative amount of retroaction varies inversely as the number of presentations given to the original material. With as many as 26 presentations, and the resulting high degree of overlearning, there is an inhibition of 46.2 per cent. When retention is measured by the saving method, relative retroaction again varies inversely as the number of repetitions, but the curve of inhibition plotted against repetitions shows a marked negative acceleration, falling from 108.5 per cent at 6 presentations to 5.3 per cent at 26 presentations. Thus by both methods of measurement retroaction decreases as learning increases, but the amount of the decrease is a function of the method, recall being much the more susceptible to inhibition.

Foucault's (**49**) interpretation of certain aspects of the serial position curve in terms of retroactive inhibition has already been discussed. Gibson (**55**) makes incidental mention of the same phenomenon. His subjects complained that as each succeeding figure

of a list appeared it 'blotted out' the preceding figure, until at the end only the last one or two could be remembered.

The Influence of Degree of Learning. This problem has taken on renewed importance from the recent discussions of the general importance of frequency for both learning and retention. Krueger (101) has made an important study of the influence upon retention after 1, 2, 4, 7, 14 and 28 days of degrees of learning represented by the percentages 100, 150 and 200. Lists of 12 monosyllabic nouns were learned and relearned by a form of the anticipation method. As degree of learning increases from 100 to 150 per cent, there is nearly a 50 per cent decrease in retention after an interval of one day, and as the interval between learning and relearning increases the relative advantage of the greater degree of learning increases. As degree of learning increases from 150 to 200 per cent, the corresponding increment in retention is usually less than one-third, and the proportion bears no consistent relation to length of interval. In general his work shows that overlearning of at least 50 per cent is highly economical for retention over intervals up to 28 days, and that the larger the interval the greater is the economy. Further degrees of overlearning are uneconomical for most intervals. It should be noted that Krueger's results contradict those of Luh (1922), a fact which may be due to differences in experimental conditions.

Ebbinghaus concluded that each repetition after learning to the threshold has been accomplished has approximately an equal effect upon retention, in that each addition of three learning repetitions means one repetition saved in relearning. Cuff (34, 35) has called this conclusion in question. He had groups of college students learn 12-item lists of consonants, digits and syllables, then take either 4, 16, or 28 additional repetitions, and relearn after 24 hours. The results exhibit no definite relation between additional repetitions and saving. Overlearning may aid, hinder or have no effect upon retention. It cannot, however, be concluded that the traditionally quoted conclusion of Ebbinghaus' is completely overthrown, since the conditions of the two experiments are in several ways widely divergent.

The Nature of the Material. It is an often-repeated generalization in discussions of retention that acts of skill are much better retained than are memorial materials. McGeoch and Melton (124) have examined the literature upon which this generalization is, presumably, based and have found numerous exceptions. They have then compared the retention values, after a seven-day interval, of three mazes of varying degrees of difficulty and nonsense syllables in lists

of 8, 12 and 16, when each maze and each list is learned to a criterion of one perfect repetition and relearned to a criterion of three successive perfect trials. The relative retention values of the two materials are functions of the particular maze and syllable list compared, of the method by which retention is measured, and of the relearning criterion employed. In terms of trials the syllable lists are unequivocally superior. In terms of time and errors the mazes excel in a majority of the comparisons, although in terms of both scores at least one syllable list is equal to or better than at least one maze. Further, when the mazes are superior, the amount of their superiority is by no means as great as that usually assigned to motor skills. The only very large difference in retention values occurs with the criterion of trials, where the syllables greatly excel the mazes. The difference between these results and those showing relatively higher retention for acts of skill is interpreted to lie in the factor of degree of learning.

Different kinds of historical knowledge have different rates of forgetting (Bassett, 4). Knowledge which is concrete and personal tends to be well remembered. Names and geographical locations are forgotten rapidly. Anderson and Jordan (1) find that the closer the formal relations between Latin words and their English equivalents the better the retention. In point also are the experiments reviewed under the curve of retention. Although comparisons of the retention values of different materials, when such values are derived under varying conditions, can have suggestive importance only, it seems that logically connected subject matter, such as history, botany and poetry, is better retained than memorial materials have often been thought to be.

Affective Tone and Retention. Meltzer (125) has summarized in tabular form 26 experimental papers on this problem and has criticized them briefly. The major shortcomings are: (A) too few subjects; (B) unreliable method-questionnaire; (C) conditions too narrowly restricted and insufficiently life-like; (D) unwarranted assumptions tacitly made, such as the assumption that the subjects have experienced equal numbers of pleasant and unpleasant activities; and (E) forced or unwarranted interpretations of results. He suggests that the problem should not be stated in terms of the influence of feeling upon memory, but rather in terms of correlation.

Data regarding the earliest childhood memories of both adults and children have been collected by Blonsky (11) and regarding those of adults by Gordon (58). The content of the memories of Blonsky's subjects was preponderantly unpleasant, and the older the

memories the greater the tendency for them to be unpleasant. Misfortune turns out to be the weightiest mnemonic factor. Upon reading Blonsky's paper one wonders if the content of the memories of persons in other parts of the world would agree with those of the inhabitants of Moscow; the factor of the experiential ratio of pleasant to unpleasant experiences must always be considered. Blonsky's conclusions find, however, emphatic support in Gordon's canvass of 750 students, which revealed that unpleasant memories bulk largest for both men and women. Neither study lends support to the Freudian doctrine of the repression of the unpleasant, although neither, as it stands, can be taken as a denial thereof.

Jones (**94**) offers a criticism of Smith's (*The Measurement of Emotion*) work, and repeats it with certain words and extends it. The mean galvanometric deflections obtained by Smith and by Jones correlate highly and agree in the placement of the highest and lowest words. The memory values for critical and non-critical words lead Jones to suggest a theory of the bidirectional influence of emotional tone upon memory. Increased emotional intensity may affect learning either favorably or adversely, depending upon whether the emotion is 'positive' or 'negative.' Words which had been evaluated for affective tone on a 5-point scale by 150 students were learned by 20 girls for Chaney and Lauer (**25**). Pleasant, unpleasant and neutral words were recalled about equally, and all were slightly inferior to the mixed lists. Selz (**152**) believes that there is a positive relation between pupils' liking for a subject and their recall thereof, but the experimental conditions are not clean-cut. Cuff (**35**) reports a slight tendency for subjects with the lowest affectivity and idiosyncrasy scores on the Pressey X-O Tests to have the largest percentages of saving. Guiraud (**66**) speaks of the induction, in abnormal states, of series of recollections under the influence of an affective tendency.

Repeated Reproduction. Departing from a critical examination of Wulf's (1922) study of ideational change, Gibson (**55**) analyzes reproduction of geometrical forms at successive sittings and after periods of five weeks and a year. The reproduction of a visually perceived form is frequently changed in the direction of a familiar associated object, and the reproduction of one figure may be changed in the direction of another figure if the two have been associated in consciousness. Gaps or breaks in the contour are partially or wholly closed up in reproduction, or else the figure 'falls apart' into separate units. These facts are interpreted as evidence for the existence of perceptual habits. Reproductive change depends upon the manner

of apprehension. Zillig (182) asked from her subjects written reports on an event immediately after its occurrence, on the next day, and after a week. She divides the subjects into three types with respect to their behavior on successive reproductions: (A) the constant type which reports repeatedly in the same manner; (B) the variable type which alters its reports on successive occasions; and (C) the intermittent type which varies its report from correctness to incorrectness.

Studies of Post-hypnotic Function. Strickler (165) has experimented systematically upon the forgetting of geometrical character-nonsense syllable paired-associates learned in the hypnotic trance and in the normal waking condition. Four subjects who showed complete waking amnesia for trance events were used. The net recall amnesia for the associates is about 80 per cent complete, while the post-hypnotic relearning amnesia is only about 50 per cent complete. In spite of excess total learning in the trance series, material thus learned suffers nearly twice as great a deterioration as does normally learned material, after a lapse of twenty-four hours. Kellogg (97) has measured the duration of the post-hypnotic suggestion that the respiration rate be varied in a certain way. The same suggestions are given to a normal group and are not significantly forgotten by them, while in the case of the hypnotized subjects the influence of the suggestion decreases during the first three weeks.

Testimony. There have been several papers and one book devoted to the general problem of testimony. Tesoro (166) gives a somewhat popular description of the factors of importance in evaluating testimony, and Claparède (29) discusses unreliable testimony. Gorphe (59) analyzes the conditions which must be taken into account in the education of ability to report. Révész (142) and Busemann (22) report cases illustrative of the unreliability of children's testimony upon sexual matters, and Plaut (139) examines in some detail what can be expected from the testimony of young psychopaths. The same writer (138) emphasizes the need for a study of the psychological conditions of the testimony of adults. Selz (153) and Kafka (96) report cases. Other studies of the ability to report have been reviewed in connection with specific problems.

Miscellaneous. Under this heading will be reviewed topics upon which but a single paper has appeared or upon which the results permit brief statement. (A) *Correlations Between Learning and Retention.* The correlations between initial history tests and tests after 4, 8, 12 and 16 months are high, 0.797 and 0.840 (Bassett, 4).

This is corroborated by Brooks and Bassett (20). Anderson and Jordan (1) obtain coefficients of 0.75 and 0.79 between immediate and delayed recalls of paired-associates after 3 and 8 weeks, respectively, and Johnson (93) reports *r*.s of 0.52 and 0.67 between the amount of botany known at the completion of the course and relative retention. (B) *Correlations Between Retention and Other Factors.* Bassett (4, 6) gives extensive tables of coefficients of correlation between the retention of history and other factors. Their nature can only be indicated here. Subject preference, interest and effort, and reading comprehension, *e.g.,* correlate positively with retention. Anderson and Jordan (1) report that immediate recall and recall after eight weeks correlate 0.46 with silent reading and 0.20 with word knowledge, and Bassett (4) finds MA and retention positively related.

(C) *Distribution and Retention.* Clark (31) has demonstrated that, for the retention of sonnets, duration of learning periods has more influence than duration of rest intervals, and that study periods decreasing in geometric progression, when compared with intervals of equal length, will reduce considerably the rate of forgetting. (D) *Sensory Modality and Method of Presentation.* Vértes (172) compared the memory of deaf-mutes and normal children, finding the deaf-mutes superior with words designated by touch images and inferior in words depending upon audition. There is no great difference in memory for things. In the Tilton and Knowlton (169) study of the effect of photoplays, the experimental group retained more of relation, person, and place knowledge, and less of time knowledge, than the control. In Greene's (62) comparison, lectures resulted in better retention than did reading; while the three methods of presentation compared by Johnson (92) are roughly equal.

(E) *The Influence of Age.* The data published by Thorndike and his associates (167) make it doubtful if forgetting is greater in the later than in the earlier adult years. Bassett (4) records a negative correlation between CA and retention. (F) *Infantile Memories.* Hadfield (67, 68) contends that memories of infantile experiences can be accurately revived and discusses the reasons for this contention and some of the errors likely to arise in the interpretation of such memories. The average ages at which the earliest memories of Gordon's (58) subjects are dated vary from 3.5 to 3.79, and Blonsky (11) gives 4.2 as the corresponding figure for his adults. The mean age of earliest memory for his subjects aged eleven to twelve is, however, 2.5. Some members of each group have memories which are referred to the first year of life. (G) *The*

Influence of Unrecalled Material. Campos and Radecki (23) and Radecka and Radecki (140) present evidence which they interpret to mean that 'forgotten' words may, nevertheless, influence voluntary associations, while having little influence upon free associations. (H) *Sex Differences.* After all intervals up to sixteen months, boys are slightly superior to girls in history retention (Bassett, 5). This superiority seems, however, to be a function of the material. The boys excel in knowledge about war and fighting and geographical places; the girls are superior in history treating of domestic relations and home life.

(I) *Rhythm.* Rhythmically learned material is retained considerably better than material of which the rhythm had been broken during learning (Elkin, 41). (J) *Recognition and Confidence.* Seward (155) sought to determine the extent to which speed of redintegrative response serves as an index of confidence. Whether positive or negative, the more accurate response is quicker and more confident than the inaccurate. When two responses are equally accurate, the negative is the faster and the more confident. Recognition time and confidence are not, however, sufficiently correlated to permit the use of the former as a measure of the latter. Jersild's (91) data indicate that confidence regarding true-false answers is a personal factor which is relatively constant, but which is no guarantee of the accuracy of the performance. (K) *The Influence of Attention.* With the transition from immediate to delayed measures of retention, the differences between discrete and total attention become neutralized (Meyer, 126). (L) *Tonal Memory.* König (99) reports that wide differences exist in tonal memory functions corresponding to differences in musical training. The trained may excel by large amounts. (M) *Errors in Reproduction.* Maity (112) puts forward the thesis that errors in reproduction are important for the study of the mental characteristics of learners, and makes an analysis of such errors. The two major types are lapses and perseverations of wrong items, both of which are made by poor learners much oftener than by those who are good learners. (N) *Cure of an Amnesic Case.* Tucker and Shield (170) describe the case of a man who had had several amnesic periods with a complete change of personality. An operative cerebral decompression was followed by a long period of normality.

III. General

Historical. The three histories of psychology published during the last two years contain valuable discussions of early work on

memory. Boring's (15) masterly volume, the quality of which any science could be proud to have to its credit, has a wealth of material for him who would understand the historical development of experimental research upon memory. Specifically in point are his sections on Ebbinghaus and on G. E. Müller; but no specific enumeration can do justice to the magnificent perspective in which Boring has marshaled the problems of experimental psychology, memory among them. Murphy (128) has a good chapter devoted to "Early Studies of Memory," in which Ebbinghaus receives the lion's share. That psychologist's subjection of learning and forgetting to quantitative treatment is evaluated as "probably the greatest triumph of original genius in experimental psychology since Weber," an interpretation which Langfeld (see 128) styles "a bit strong." References to work on memory occur frequently in Pillsbury's (137) *History*, Ebbinghaus and Müller again being given major treatment.

General Textbook Chapters. No attempt will be made to present under this caption a review of the chapters on memory in all of the textbooks published during the period of this review. Such an attempt would have to include texts in educational and applied, as well as in general, psychology and would run into more pages than should be given to brief accounts intended primarily for beginning students. A few books, however, present new points of view which demand special mention. Some of these will be treated also in the following section on contributions to theory. To the extent that the redintegrative paradigm is both a fact of nature and the framework (as well as most of the structure) of learning, Hollingworth's (77) whole book is based on and permeated with the principles of learning and memory, a mode of treatment which is one of the first overtly to recognize the systematic pervasiveness and generality of the concept of learning. His specific treatment of memory is stimulating and unique. Against the background of a configurational point of view, under the aegis of "least action," Wheeler (176) devotes three chapters to an account of learning in which there is much that is both new and important. Dashiell (38) gives less space to memory, but makes a thoroughgoing effort to give it objective status. Each of these three authors introduces new material, cites contemporary experiments, reinterprets old ones, and departs refreshingly from the hackneyed recitation of traditional facts into which textbook writers have sometimes fallen.

Books and Pamphlets. Bode's (13) *Conflicting Psychologies of Learning* particularly concerns itself with the implications for educa-

tion of various theories of mind. It has little or nothing to do with theories of learning in the technical sense, but deals rather with the wider context which determines the framework within which the specific theories of learning must be framed. The chapters on association and reproduction in Köhler's (98) *Gestalt Psychology* are critical analyses of prevailing viewpoints and constructive presentations of the *Gestalt* interpretations. The whole book provides the setting for a new theory of memory.

In a book which, though elementary, has the merit of both critical acquaintance with the historical and systematic relationships of memory and of fluid and engaging style, Janet (87) has set forth the relations between memory and time. The end of memory is to triumph over time and absence, which in themselves are prior to memory. Repeated use is made of illustrations and principles from the data of mental abnormality.

Burton (21) writes a general text for normal school and college students, and Wiley (178) lists in pamphlet form some 'practical' suggestions to students. Crawford's (32) survey of student opinion and of student activities has considerable practical significance. Markey (113) reviews work on the acquisition of symbols, which lies on the borderland between memory and skill. Forsberg (47) has surveyed some of the literature on memory and has presented experiments and conclusions of his own regarding the problems of understanding, learning and memory. Emphasis is placed on a study of 'natural' learning.

General Surveys of Learning and Retention. In Murchison's *The Foundations of Experimental Psychology* appear two chapters on learning which are of the first order of excellence. Lashley (103) surveys the nervous mechanisms involved in learning and treats of the phylogenetic development of learning capacity, the relation between learning and neural structure, the nature of central integration and the major "laws of learning." Hunter (82) writes on experimental studies of learning and summarizes the existent data upon the active problems of learning and retention. Both chapters include, also, work on the acquisition of skill and, to some extent, upon animals. In each the emphasis is on experimental fact only. Each author organizes and interprets critically and clearly. In Robinson and Robinson, *Readings in General Psychology,* McGeoch (123) has written a section on experimental studies of memory. He has also described (118) some of the major conditions of human forgetting.

Skaggs (157) offers a systematic classification of inhibition at the descriptive and psychological level. Voluntary inhibition may be of images or ideas, sense-presentations or of motor activity. Involuntary or passive inhibition has four varieties: (A) that operative at the time of learning, including associative, retroactive and affective inhibition; (B) that operative during recall, which may be cognitive or affective; (C) sensory inhibition, including attention-inhibition and reciprocal sensory inhibition; and (D) motor inhibition, as when a stimulus stops a movement. Retroactive inhibition and retrograde amnesia are held not to be the same.

Three papers on psychology and the law of evidence have been written by Hutchins and Slesinger (83, 84, 85) in order to make explicit the psychological assumptions of the law and to apply critically the data of modern psychology. In each paper certain assumptions and practices are evaluated in terms of the experimental facts upon memory, among others. The psychological sophistication exhibited in these papers marks a notable advance over the older slipshod acceptances and uninformed polemics which have so often attended efforts to apply the data of experimental work in psychology to an evaluation of testimony.

IV. Theoretical

The Nature of Learning. The theoretical treatments of this problem are, for the most part, sharply sundered by the insight vs. frequency issue in some of its forms. For Köhler (98) organization must be accepted as an original aspect of experience; association is but an after-effect of this organization. Contiguity is discarded on the ground that the law takes no account of the properties by virtue of which the contiguous events are associated. Such a statement has no counterpart in physics or chemistry. For him, ". . . neighborhood in space and time influences association only insofar as it determines organization," and the latter is either spontaneously present or may be created intentionally. A list of syllables, *e.g.*, is not learned because of the successive contiguity, but because the subject creates an organization intentionally. Such learning is unnatural, for in most of the acquisitions of everyday life organization is spontaneous. This view of learning is an antidote to the supposedly-current atomism, but for explanatory power it rests too heavily upon its postulates. In all cases where spontaneous organization occurs there is no need for learning, since it is already there as a given, and only retention remains a problem. Where organization must be inten-

tionally created learning enters, but here nothing is said regarding the properties of either situation or learner which render such creation possible. Surely one can demand as validly that these properties be specified as can Köhler that the law of contiguity define those of contiguously associated items A and B. Either type of organization, spontaneous or natural, must be accepted with natural piety wherever found, in which case the whole of memorizing either rests on a postulate or else the properties whereby in particular cases organization is possible must be specified. These criticisms do not, of course, apply on the level of the phenomenal description of mental life at any given moment, but only to the systematic interpretation of the flow of events.

A majority of Wheeler's (176) treatment applies more directly to the learning of motor acts than to the acquisition of memorial materials, although he clearly intends to apply the same principles to both. He regards learning as "behavior in terms of which the individual extends his insight into a given situation and increases the complexity of his actions with respect to a certain goal. When memorizing has occurred, one does not use fewer cues (*cf.* Hollingworth), instead he uses more, but they may have changed from the easily detected to the difficult to observe, and will have become better organized. Further, we do not learn by experience, unless we have "sufficient insight into the experience to profit by it, in which case it is the insight into the experience which measures progress, not the experience into which one has insight." Repetition is valuable only in so far as it induces maturation. Frequency "bears the same relation to maturation and learning that time bears to growth." Stimulus-pattern and maturation are the major factors in learning.

Much more would need to be said about this, as well as about the other points of view described in this section, to give a well-rounded picture; and far more would have to be said than can be written here if a fair attempt at evaluation were to be made. Briefly, however, Wheeler's insistence that insight is basic and that maturation, not frequency, is of importance, places the burden of learning outside of the range of antecedently operating principles and properties. It takes the developed insight as final, when insight is description after the fact; and it depends on maturation when such maturation is, in a majority of the experiments upon memory, hypothetical at best.

The learning of the relation of opposition by children aged 5.0 to 7.6 years has been studied by Kreezer and Dallenbach (100) and has yielded results which bear directly upon this problem. No subject

learned the relation gradually; it came suddenly with the acquisition of 'insight,' and once learned was not forgotten. The subjects learned the relation as such and not as a specific response. The existence of this type of learning is cited as evidence of the inadequacy of trial-and-error theories. The law of exercise, even though eked out by assimilation, is interpreted to be futile, as is recency, to explain the results. Frequency, recency and assimilation should have led to a continuation of the wrong response, and neither can have anything directly to do with the sudden appearance of the correct response. This experiment constitutes a striking example of sudden learning of the insightful variety, but the authors offer insight as a description, not as an explanation.

The experimental results of Kreezer and Dallenbach offer one reply to certain of Lund's (110) criticisms of the *Gestalt* insistence that learning proceeds, not by trial-and-error and the gradual selection of correct adjustments from random movements, but by sudden insight. Lund puts forward four criticisms: (A) it is a question whether sudden drops in the learning curve are typical; (B) even in Köhler's report of the learning of apes, some gradual perfecting appeared; the apes did not sit and deliberate until 'insight' came; (C) such insight as appears may be a case of transfer from previous acquisitions through trial-and-error; and (D) Köhler's preferred illustrations of sudden insight are cases in which the right act either does or does not occur. Without aiming at an evaluation of the two theoretical positions involved, it may be pointed out that the Kreezer and Dallenbach experiment presents one case in which there is no gradual acquisition, although in one form such would have been possible, and in which it is difficult to see how transfer of the kind described could have operated. Whether such learning is typical is another matter and one which research must decide.

Consonant with Lund's critique is a paper by Razran (141), who has examined nearly 200 original reports on the conditioned response and on negative adaptation and who presents them in a series of generalizations. He raises the question whether the more complex forms of learning proceed according to the known principles of conditioning. He thinks that they can be interpreted thus: poem-reciting is "adequately accounted for by proprioceptive and chained conditioning in which the response, or rather the proprioceptive part, of the first pattern becomes conditioned to the response of the second pattern, the response of the second to that of the third, and so on . . ." For Dashiell (38) the conditioned response is explicitly taken as "the

type and the elementary complete unit of all learning," but he is careful to state with equal explicitness that the situation is always more complex than the simple conditioned response paradigm makes it seem to be. To him, learning by insight is but learning to react to some highly specific element of a situation, "but that element is still a stimulus, however refined; and learning to react to it and nothing else is still a coupling of a motor response to a sensory signal." Herrick (75) likewise considers the conditioned response a fundamental paradigm, and Leary (105) believes that the conditioned response will suffice to explain all learning.

For Hollingworth (77) memorizing is the process of establishing the redintegrative effectiveness of subtle cues, the reduction of the requisite antecedent. The conditions favoring and retarding the rate of this reduction are well described, but one looks in vain for the principles or properties which render such reduction possible. *That* subtle cues come to stand for total patterns is clearly set forth; *how* they do, whether by frequency, by insight, or by some other factor, is not so clearly shown, although Hollingworth's treatment points toward a frequency doctrine, eked out by other factors of the same order, rather than toward insight.

In these accounts of learning, description of the completed event is mingled with interpretations of how that event came to its described completion. The former is a matter for experimental determination and is less directly open to dispute; the latter is more subject to interpretation in the light of theoretical considerations. However open to criticism the theoretical positions reviewed may seem to any particular reviewer to be, they are still significant and refreshing, and they amount to a rejuvenation of many problems of learning which were fast becoming sterile. This is achieved (A) by an attempt to envisage learning in a larger setting than that which it has usually been given in experimentation, and (B) by coördinating theories and facts of learning with a wider systematic structure.

Theories of Memory. Experimentalists have generally concerned themselves very little with the nature of memory. Fortified by the ready analogy of the phonograph record it has been possible to satisfy untrained inquirers while remaining undisturbed by the puzzling nature of the real problem. In some of the recent writing, however, the problem of memory has begun to receive critical treatment. Hollingworth (77) points out that memory is not the reproduction or resurrection of the past. A past event is remembered only by encountering a new event which can serve as a surrogate for the past

event. Such symbols typically operate unreported. Memory is thus not a matter of storing, but an act of restoration in which new events assume old patterns or relations. The changes which time brings to 'reproduced' content are largely the outcome of the loss of the cues which upon their first appearance were responses to the presented material. One wishes that Hollingworth had discussed the conditions which bring about the lapsing of the cues. Wheeler's (176) proposed theory has several points in common with Hollingworth's. Recall is not revival: "it is an effort on the part of the individual to experience a situation as he perceived it before." ". . . The difference between the responses to the earlier situation and the response to the situation partly repeated is the difference between original observation (perception) and memory." Memory is constructed not from residues but from present sensory stimuli. Remembering is thus an incomplete process of perceiving, initiated by some of the stimuli which conditioned the original experience. Behind this view there lies a theory of traces, as we shall presently see. For Köhler (98) reproduction is a matter not of association but of the operation of a total field, and depends upon the fate of 'traces.' Dashiell (38) treats memory as one with habit which depends on an appropriate stimulus for elicitation. One finds in Janet's (87) book a good critical survey of historical theories of memory and a well written exposition of the integral relation of memory and time. The former is a construct, peculiar to man, whereby he triumphs over time.

Bousfield (16) devotes a short book to a critique of mechanical theories of memory and to the presentation of a view of his own. The defects in a theory such as that of Semon's, *e.g.*, are: (A) one can obtain no direct evidence of a permanent change in cerebral cells which might form the foundation of memory; and (B) it assumes a definite molecular regrouping to correspond differentially to every possible impression, and such a definite and mechanical pattern can take no account of the diverse ways in which the same meaning can be reproduced, thus making the fatal mistake of leaving meaning entirely out of account. He holds that the essential thing in memory is the meanings, the ideas, not the words or the engrams. He regards the cerebral cells as organs for transmission rather than for storing. The latter must, however, be done somewhere and he presents an hypothesis which assumes: (A) a psychic structure as the basis of memory, which (B) involves an immaterial organization which serves to integrate a complex of sensory stimuli. How sensations are transmuted into ideas and retained as meanings is unknown, but that

the meanings are the important factor and that their retention involves a non-material organization is the major issue. By such an hypothesis, he holds, the specific areas of forgetting which occur in hysteria, following injuries and the like, are much more easily explained than by an engram view, since it is hard to see how an injury could pick out all the engrams deposited during the past week or about a given logical or grammatical focus. Bousfield's view has other points which will not be enumerated, but its chief characteristic is its attack upon mechanical theories of memory and its championing of retention as occurring in some immaterial form of organization which may be, he says, some form of modification of the ether. His criticisms are well put and are supported by contemporary work on cerebral function. His hypothesis will seem to most readers as somewhat less parsimonious with assumptions than one would like.

This attack upon the engram theory of memory leads to a review of the current statements about where and how 'memories' are stored. The first part of this section reviewed the descriptions of memory as an experienced mental event; this part will consider the 'traces' supposed to perdure from an experience to its remembering. The most frequently stated view is that experience leaves physical traces of some sort in the neurones of the cerebral cortex and that these traces are rearoused by stimuli similar to those of the original experience. Some of these theories are more sophisticated than others, of course. Learning is for Dashiell (38) a matter of synaptic change and retention a persistence of the altered synaptic condition. Bridges (17) subscribes to a neural view of memory. Learning is considered to be the formation of new bonds between neurones. Memory traces are not, however, effects in single cells but in the arrangement and relationship of cells. Traces are, for Herrick (75) structural alterations of brain tissue, but they are not passive. They are to be conceived as alterations of tensions which may react with one another at subconscious levels. This has some points in common with the *Gestalt* position that configurations are retained, not as specific traces, but as systems of stresses (Köhler, 98; Wheeler, 176). The effect of the eliciting stimulus is determined by its relation to the pattern of stresses functional at the time. The physiological stresses are not, of course, unchangeable impressions, but continually undergo change expressible in *Gestalt* laws. The two general tendencies are accentuating and leveling which have the common feature that both work toward the production of a 'better' *Gestalt*. (See Gibson, 55, and Hsiao, 81.) The points of view stated are typical of many

allusions to the mechanisms of retention. They have the common characteristic that all place the traces, which are assumed to be necessary, within the cortex.

The outstanding exception to this interpretation, aside from the theory of Bousfield, is to be found in Hollingworth's book. He deals with memory, as with all other mental events, without reference to the nervous system. All occur within the world of symbols, redintegratively operating, which is for him the world of mind. Memorial function takes its place within the continuum of natural events and no problem of mind-brain correlation exists.

The general willingness to place memorial residues within the brain depends for its validity upon the use made of the 'trace' concept. If it is frankly an attempt to guess where the assumed neural counterparts of remembered events are to be found, and nothing else, it has at least the status of an interesting conjecture. If, however, as is often done, either explicitly or implicitly, the neural traces are fallen back upon for explanation of the experimental facts of memory, logicality vanishes. One can not validly explain a sequence of remembered events by a set of traces, whether static effects or fluid stresses, which are not even known to exist and which are constructs made in the image of the memorial facts which they are then invoked to explain.

The Problem of Temporal Reference. This problem has long been known to the philosopher, but the experimentalist has glibly taken it for granted. It is noteworthy that reference to it appears occasionally in contemporary writing, although a systematic discussion is lacking. Events, as Hollingworth sees them, are given appropriate place in a system of report as they pass, and within this system they are symbolically placed according to their calendar notation. Likewise Bridges (17) writes: "the temporal reference of ideas is dependent upon their association with ideas of time such as calendar dates." For Wheeler, behavior in recall has only a logical reference to the past, it *means* the past. These statements take cognizance of the problem; one would like to see them elaborated. Janet's whole book furnishes material of importance for this problem.

Miscellaneous. Cathcart and Dawson (24) have demonstrated a phenomenon of the same class as Hollingworth's law of central tendency. When a subject is asked to remember an antecedent stimulus and to adjust a succeeding one to an equal intensity, *e.g.*, he does not go far enough toward the standard but accepts as equal a stimulus midway between his starting point and the standard. This

'persistence' factor they consider to be a general characteristic. Bloor (12) holds that forgetting does not mean that all traces have been lost. The trace of the forgotten fact endures subconsciously. Hosiasson (79) discusses forgetting and the subconscious. Claremont (30) recommends that memory be thought of after the analogy of the "button" of a searchlight beam, which can search within for records of consciousness. Masson-Oursel (116) discusses recall and retention as two techniques of memory, and Lindworsky (107) anwers the critics of the theory of reproduction enunciated in his *Theoretischen Psychologie*. Rosenow (146) holds that recall in apparently complete posthypnotic amnesia is a matter of restoring the subject's original attitude of coöperation with the experimenter. Ewald (43) would add to memorial plasticity what he considers a second and independent factor, *viz.*, the size of complex which the learner is able to handle. The analogy between memory and heredity has been drawn again by MacBride (111) and by Crow (3?).

BIBLIOGRAPHY

1. Anderson, J. P., and Jordan, A. M., Learning and Retention of Latin Words and Phrases. *J. Educ. Psychol.*, 1928, **19**, 485–496.
2. Awaji, Y., Intelligenzprüfung im japanischen Heere. *Zsch. f. angew. Psychol.*, 1928, **30**, 81–118.
3. Barlow, M. C., The Rôle of Articulation in Memorizing. *J. Exper. Psychol.*, 1928, **11**, 306–312.
4. Bassett, S. J., Retention of History in the Sixth, Seventh, and Eighth Grades with Special Reference to the Factors that Influence Retention. *Johns Hopkins Univ. Stud. in Educ.*, 1928, No. 12, pp. 110.
5. Bassett, S. J., Sex Differences in History Retention. *Sch. and Soc.*, 1929, **29**, 397–398.
6. Bassett, S. J., Factors Influencing Retention of History in the Sixth, Seventh and Eighth Grades. *J. Educ. Psychol.*, 1929, **20**, 683–690.
7. Belanner, I., Hur hjälpa minnet för tal och årtal? *Ark. f. Psykol. o. Ped.*, 1929, **8**, 50–53.
8. Biddle, A. E., An Analytic Study of One Class in High School. *Psychol. Clin.*, 1928, **17**, 97–118.
9. Bills, A. G., and Brown, C., The Quantitative Set. *J. Exper. Psychol.*, 1929, **12**, 301–323.
10. Blachowski, S., Badania z zakresu rozwoju pamieci lieb i zdolnosci rachunkowych. *Polskie Arch. Psychol.*, 1927, **1**, 122–141.
11. Blonsky, P., Das Problem der ersten K dheitserinnerung und seine Bedeutung. *Arch. f. d. ges. Psychol.*, 19 71, 369–390.
12. Bloor, C., Some Notes on Memory. *Psycl* 1928, **8**, 89–96.
13. Bode, B. H., *Conflicting Psychologies of l ming*. N. Y.: Heath & Co., 1929.

14. BORING, E. G., Demonstrational Experiments in Memory. *Amer. J. Psychol.*, 1928, **40**, 513–514.
15. BORING, E. G., *A History of Experimental Psychology*. N. Y.: Century, 1929.
16. BOUSFIELD, W. R., *The Basis of Memory*. N. Y.: Norton, 1928.
17. BRIDGES, J. W., *Psychology: Normal and Abnormal*. N. Y.: Appleton, 1930.
18. BRINKMANN, M., Über die Schulung der Beobachtung und ihre Bedeutung insbesondere für die Arbeitsschule. (*Untersuch. z. Psychol., Phil., u. Päd.*, 1927, **6**, No. 2.) Göttingen, Akad. Buchh., pp. 228.
19. BROOKE, M. C., Results of Examination of 91 Girls at a State Institution. *Psychol. Clin.*, 1928, **17**, 22–28.
20. BROOKS, F. D., and BASSETT, S. J., The Retention of American History in the Junior High School. *J. Educ. Res.*, 1928, **18**, 195–202.
21. BURTON, W. H., *The Nature and Direction of Learning*. N. Y.: Appleton, 1929.
22. BUSEMANN, A., Psychologische Beobachtungen anlässlich eines Sexualprozesses mit jugendlichen Zeuginnen. *Zsch. f. angew. Psychol.*, 1929, **33**, 388–404.
23. CAMPOS, N., and RADECKI, W., Pesquisas experimentaes da influencia do material mnemonico esquecido sobre a associação voluntaria. *Ann. da Colon. de Psychopath.*, 1928, **1**, 219–243.
24. CATHCART, E. P., and DAWSON, S., Persistence (2). *Brit. J. Psychol.*, 1929, **19**, 343–356.
25. CHANEY, R. M., and LAUER, A. R., The Influence of Affective Tone on Learning and Retention. *J. Educ. Psychol.*, 1929, **20**, 287–290.
26. CHENG, N. Y., Retroactive Effect and Degree of Similarity. *J. Exper. Psychol.*, 1929, **12**, 444–449.
27. CHOU, S. K., A Quadrant Tachistoscope for Studying the Legibility of Chinese Characters. *J. Exper. Psychol.*, 1929, **12**, 178–186.
28. CHOU, S. K., An Automatic Card Feeder and Catcher Mechanism. *J. Gen. Psychol.*, 1930, **3**, 179–182.
29. CLAPARÈDE, E., Le témoignage. *Psychol. et vie*, 1928, **2**, 103–106.
30. CLAREMONT, C. A., The Memory of Memories. *Psyche*, 1929, **9**, 44–52.
31. CLARK, B. E., The Effect Upon Retention of Varying Lengths of Study Periods and Rest Intervals in Distributed Learning Time. *J. Educ. Psychol.*, 1928, **19**, 552–559.
32. CRAWFORD, A. B., *Incentives to Study*. New Haven: Yale Univ. Press, 1929.
33. CROW, W. B., Heredity and Memory. *Psyche*, 1929, **9**, 53–60.
34. CUFF, N. B., The Relation of Overlearning to Retention. *Geo. Peabody Coll. for Teachers, Contr. to Educ.*, 1927, No. 43. Pp. 34.
35. CUFF, N. B., The Law of Use. *J. Educ. Psychol.*, 1929, **20**, 438–447.
36. CUSHING, H. M., A Perseverative Tendency in Pre-school Children. *Arch. of Psychol.*, 1929, **17**, No. 108. Pp. 55.
37. DAHL, A., Über den Einfluss des Schlafens auf das Wiedererkennen. *Psychol. Forsch.*, 1928, **11**, 290–301.
38. DASHIELL, J. F., *Fundamentals of Objective Psychology*. N. Y.: Houghton Mifflin, 1929.

39. Dorcus, R. M., and Weigand, G. E., The Effect of Exhaust Gas on the Performance in Certain Psychological Tests. *J. Gen. Psychol.*, 1929, **2**, 73–95.

40. Droba, D. D., Effect of Printed Information on Memory for Pictures. *The Museum News*, 1929, **7**, 6–8.

41. Elkin, D., Über den Einfluss des Rhythmus und des Tempos auf den Gedächtnisprozess. *Arch. f. d. ges. Psychol.*, 1928, **64**, 81–92.

42. Elkine, D., and Krasnopolsky, E., Sur la question des entraves associatives. *J. de Psychol.*, 1929, **26**, 581–603.

43. Ewald, F., Untersuchungen über die Komplexweite des Gedächtnisses. *Arch. f. d. ges. Psychol.*, 1929, **67**, 161–240.

44. Farson, M. R., A Report on the Examination of One Hundred 6B Children in Philadelphia Schools. *Psychol. Clin.*, 1928, **17**, 128–152.

45. Fenton, N., and Hill, V. D., An Experimental Study of a Visual Method in Latin Instruction. *Sch. Rev.*, 1928, **36**, 675–678.

46. Fischler, D., and Ullert, I., Contribution a l'étude des tests de mémoire immédiate. *Arch. de Psychol.*, 1929, **21**, 293–306.

47. Forsberg, J., *Förstaende och minne, en undersökning rörande vuxnas studiemetoder.* Upsala: Svenson, 1928.

48. Foster, J. C., Verbal Memory in the Preschool Child. *Ped. Sem. and J. Genet. Psychol.*, 1928, **35**, 26–44.

49. Foucault, M., Les inhibitions internes de fixation. *L'Ann. Psychol.*, 1928, **29**, 92–112.

50. Friedländer, A. A., Ein Fall aussergewöhnlicher Gedächtnisleistung. *Psychiat.-Neur. Woch.*, 1928, **30**, 1–202.

51. Galley, L., Tachistoskopische Versuche über Residuen. *Zsch. f. Psychol.*, 1929, **110**, 1–50, 194–234.

52. Garfunkel, B., Eidetik bei Hilfsschülern. *Zsch. f. angew. Psychol.*, 1929, **33**, 304–357.

53. Garrett, H. E., The Relation of Tests of Memory and Learning to Each Other and to General Intelligence in a Highly Selected Adult Group. *J. Educ. Psychol.*, 1928, **19**, 601–613.

54. Ghosal, S. C., On the Waste Involved in Postponing the Fixing of Meaningful Associations. *Indian J. Psychol.*, 1929, **4**, 68–71.

55. Gibson, J. J., The Reproduction of Visually Perceived Forms. *J. Exper. Psychol.*, 1929, **12**, 1–39.

56. Gillespie, F. R., and Brotemarkle, R. A., Interpolated Revision of College Adult-Level Norms for Personnel Procedure. *J. Appl. Psychol.*, 1929, **13**, 325–345.

57. Glaze, J. A., The Association Value of Non-sense Syllables. *Ped. Sem. and J. Genet. Psychol.*, 1928, **35**, 255–267.

58. Gordon, K., A Study of Early Memories. *J. Delinq.*, 1928, **12**, 129–132.

59. Gorphe, R., L'educabilité du témoignage. *Psychol. et vie.*, 1929, **3**, 53–56.

60. Graham, J. L., A Quantitative Comparison of Rational Responses of Negro and White College Students. *J. Soc. Psychol.*, 1930, **1**, 97–120.

61. Gray, C. T., and Bingham, C. W., A Comparison of Certain Phases of Musical Ability of Colored and White Public School Pupils. *J. Educ. Psychol.*, 1929, **20**, 501–506.

62. GREENE, E. B., The Relative Effectiveness of Lecture and Individual Reading as Methods of College Teaching. *Genet. Psychol. Monog.*, 1928, **4**, No. 6, 463–560.

63. GRIOLET, S., Une hypothese différentielle sur la loi de l'oubli. *Rev. Philos.*, 1928, **105**, 464–468.

64. GRIOLET, S., Sur la loi de l'oubli et sur l'arbitraire possible des formules mathématiques en psychologie. *Rev. Philos.*, 1929, **108**, 419–428.

65. GUDEFF, P. T., *Gedächtnis und Erfahrungen.* (Tr. O. Müller.) Berlin: Deutsche Runds., 1928.

66. GUIRAUD, P., Souvenirs d'enfance et idées de grandeur. *Ann. méd.-psychol.*, 1928, **86**, 202–210.

67. HADFIELD, J. A., The Reliability of Infantile Memories. *Brit. J. Med. Psychol.*, 1928, **8**, 87–111.

68. HADFIELD, J. A., The Reliability of Infantile Memories. *Lancet*, 1928, **214**, 1259–1262.

69. HANSEN-TYBJERG, C., Differences in the Talents and Abilities of Young People. *J. App. Psychol.*, 1929, **13**, 451–468.

70. HARDEN, L. M., A Quantitative Study of the Similarity Factor in Retroactive Inhibition. *J. Gen. Psychol.*, 1929, **2**, 421–430.

71. HARTMANN, G. W., Precision and Accuracy. *Arch. of Psychol.*, 1928, **16**, No. 100. Pp. 42.

72. HEGGE, T. G., Bemerkungen zum Aufsatz von Isaak Spielrein: Die Realität von Wortinhalten und ihre Reproduzierbarkeit. *Zsch. f. angew. Psychol.*, 1928, **31**, 111–114.

73. HEGGE, T. G., An Experiment in the Logical Memory of Subnormals. *Tr. Sch. Bull.*, 1929, **26**, 82–86.

74. HERON, W. T., The Warming-up Effect in Learning Nonsense Syllables. *Ped. Sem. and J. Genet. Psychol.*, 1928, **35**, 219–227.

75. HERRICK, C. J., *The Thinking Machine.* Chicago: Univ. of Chicago Press, 1929.

76. HERRMANN, A., Über die Fähigkeit zu selbständigem Lernen und die natürlichen Lernweisen zur Zeit der Volksschulereife. (Experimentelle Untersuchungen über den natürlichen Lernvorgang. I. Ed. by O. Selz.) *Zsch. f. Psychol.*, 1928, **109**, 116–190.

77. HOLLINGWORTH, H. L., *Psychology: Its Facts and Principles.* N. Y.: Appleton, 1928.

78. HOLLINGWORTH, H. L., General Laws of Redintegration. *J. Gen. Psychol.*, 1928, **1**, 79–90.

79. HOSIASSON, S., Les oublis et le subconscient. *Psychol. et vie*, 1928, **2**, 123–127.

80. HOSIASSON, S., La mémoire des choses lués. *Psychol. et vie*, 1928, **3**, 15–18.

81. HSIAO, H. H., A Suggestive Review of *Gestalt* Psychology. *Psychol. Rev.*, 1928, **35**, 280–297.

82. HUNTER, W. S., Learning: II. Experimental Studies of Learning. Chap. 15 in *The Foundations of Experimental Psychology.* Ed. by C. Murchison. Worcester: Clark Univ. Press, 1929. Pp. 564–627.

83. HUTCHINS, R. M., and SLESINGER, D., Some Observations on the Law of Evidence. *Columbia L. Rev.*, 1928, **28**, 432–440.

84. HUTCHINS, R. M., and SLESINGER, D., Some Observations on the Law of Evidence—Memory. *Harvard L. Rev.*, 1928, **41**, 860–873.
85. HUTCHINS, R. M., and SLESINGER, D., Legal Psychology. *Psychol. Rev.*, 1929, **36**, 13–26.
86. JAENSCH, E. R., and MEHMEL, H., Gedächtnisleistung eines schwachsinnigen Eidetikers. *Psychiat.-Neur. Woch.*, 1928, **30**, 101–103.
87. JANET, P., *L'evolution de la mémoire et de la notion de temps.* Paris: Chahine, 1928.
88. JERSILD, A., Modes of Emphasis in Public Speaking. *J. Appl. Psychol.*, 1928, **12**, 611–620.
89. JERSILD, A., Examination as an Aid to Learning. *J. Educ. Psychol.*, 1929, **20**, 602–609.
90. JERSILD, A., Primacy, Recency, Frequency and Vividness. *J. Exper. Psychol.*, 1929, **12**, 58–70.
91. JERSILD, A., The Determinants of Confidence. *Amer. J. Psychol.*, 1929, **41**, 640–642.
92. JOHNSON, P. O., A Comparison of the Lecture-Demonstration, Group Laboratory Experimentation, and Individual Laboratory Experimentation Methods of Teaching High School Biology. *J. Educ. Res.*, 1928, **18**, 103–111.
93. JOHNSON, P. O., The Permanence of Learning in Elementary Botany. *J. Educ. Psychol.*, 1930, **21**, 37–47.
94. JONES, H. E., Emotional Factors in Learning. *J. Gen. Psychol.*, 1929, **2**, 263–270.
95. JONES, H. E., CONRAD, H., and HORN, A., Psychological Studies of Motion Pictures. II. Observation and Recall as a Function of Age. *Univ. Calif. Pub. Psychol.*, 1928, **3**, 225–243.
96. KAFKA, G., Ein Aussageversuch mit Kriminalbeamten. *Zsch. f. angew. Psychol.*, 1928, **31**, 173–201.
97. KELLOGG, E. R., Duration of the Effects of Post-hypnotic Suggestion. *J. Exper. Psychol.*, 1929, **12**, 502–514.
98. KÖHLER, W., *Gestalt Psychology.* N. Y.: H. Liveright, 1929.
99. KÖNIG, H., Über das musikalische Gedächtnis. *Zsch. f. Psychol.*, 1928, **108**, 398–420.
100. KREEZER, G., and DALLENBACH, K. M., Learning the Relation of Opposition. *Amer. J. Psychol.*, 1929, **41**, 432–441.
101. KRUEGER, W. C. F., The Effect of Overlearning on Retention. *J. Exper. Psychol.*, 1929, **12**, 71–78.
102. KURKA, G., Die Wirkung verschiedener alkolischer Getränke auf geistige Leistungen. *Zsch. f. angew. Psychol.*, 1928, **30**, 430–532.
103. LASHLEY, K. S., Learning: I. Nervous Mechanisms in Learning. Chap. 14 in *The Foundations of Experimental Psychology.* Ed. by C. Murchison. Pp. 524–563. Worcester: Clark Univ. Press, 1929.
104. LATON, A. D., The Psychology of Learning Applied to Health Education Through Biology. *T. C. Contr. to Educ.*, 1929, No. 344. Pp. 103.
105. LEARY, D. B., *Modern Psychology.* Phila.: Lippincott, 1928.
106. LIGHTFOOT, J. M., The Study of a Special Class Center. *Psychol. Clin.*, 1928, **17**, 190–199.

107. LINDWORSKY, J., Einige Bemerkungen über den Reproduktionsvorgang. *Arch. f. d. ges. Psychol.*, 1929, **67**, 437–440.
108. LÖSER, J., Teilgedächtnisse bei Debilen. *Hilfsschule*, 1928, **21**, 156–161.
109. LOWERY, H., Musical Memory. *Brit. J. Psychol.*, 1929, **19**, 397–404.
110. LUND, F. H., The Phantom of the *Gestalt*. *J. Gen. Psychol.*, 1929, **2**, 307–321.
111. MACBRIDE, E. W., *The Idea of Memory in Biology*. London: Oxford Univ. Press, 1928. Pp. 27.
112. MAITY, H. P., An Analytical Study of Memorisation Process. *Indian J. Psychol.*, 1928, **3**, 175–184.
113. MARKEY, J. F., *The Symbolic Process and Its Integration in Children*. N. Y.: Harcourt, Brace, 1928.
114. MARTIN, P. R., and FERNBERGER, S. W., Improvement in Memory Span. *Amer. J. Psychol.*, 1929, **41**, 91–94.
115. MASO, N., La valeur de l'activité de l'esprit dans la fixation des idées. *Arch. de Psychol.*, 1929, **21**, 275–292.
116. MASSON-OURSEL, P., Les deux techniques de la mémoire: retrouver, retenir. *Psychol. et vie*, 1929, **3**, 57–59.
117. MCFARLAND, R. A., An Experimental Study of the Relationship Between Speed and Mental Ability. *J. Gen. Psychol.*, 1930, **3**, 67–96.
118. MCGEOCH, J. A., Some Phases of Human Forgetting. *Quart. J. Univ. N. Dakota*, 1928, **18**, 345–354.
119. MCGEOCH, J. A., The Influence of Sex and Age Upon the Ability to Report. *Amer. J. Psychol.*, 1928, **40**, 458–466.
120. MCGEOCH, J. A., The Relation Between Different Measures of Ability to Report. *Amer. J. Psychol.*, 1928, **40**, 592–595.
121. MCGEOCH, J. A., Intelligence and the Ability to Report. *Amer. J. Psychol.*, 1928, **40**, 596–599.
122. MCGEOCH, J. A., The Influence of Degree of Learning Upon Retroactive Inhibition. *Amer. J. Psychol.*, 1929, **41**, 252–262.
123. MCGEOCH, J. A., Experimental Studies of Memory. In *Readings in General Psychology*. Ed. by E. S. and F. R. Robinson. Sec. Ed. Pp. 369–412. Chicago: Univ. of Chicago Press, 1929.
124. MCGEOCH, J. A., and MELTON, A. W., The Comparative Retention Values of Maze Habits and of Nonsense Syllables. *J. Exper. Psychol.*, 1929, **12**, 392–414.
125. MELTZER, H., The Present Status of Experimental Studies on the Relationship of Feeling to Memory. *Psychol. Rev.*, 1930, **37**, 124–139.
126. MEYER, E., Experimentelle Untersuchungen über totale und diskrete Aufmerksamkeit beim Übergang vom unmittelbar zum dauerenden Behalten. *Arch. f. d. ges. Psychol.*, 1929, **72**, 321–516.
127. DE MORTIER, G., Le syndrome préfrontal: l'amnesie de fixation. *Encéph.*, 1929, **24**, 19–49.
128. MURPHY, G., *An Historical Introduction to Modern Psychology*. N. Y.: Harcourt, Brace, 1929. See also a review of this book by Langfeld, H. S., *Psychol. Bull.*, 1930, **27**, 132–134.
129. NETSCHAJEFF, A., Zur Frage über Ermüdungsmessungen. *Arch. f. d. ges. Psychol.*, 1928, **63**, 237–248.

130. NETSCHAJEFF, A., Psychologische Untersuchungen an Kindern im Alter von 4 bis 8 Jahren. *Zsch. f. angew. Psychol.*, 1928, **29**, 375–392.

131. NEWHALL, S. M., and HEIM, M. H., Memory Value of Absolute Size in Magazine Advertising. *J. Appl. Psychol.*, 1929, **13**, 62–75.

132. NOICA, —., La mémoire de prononciation dans l'aphasie motrice. *J. de Neur. et de Psychiat.*, 1929, **29**, 201–207.

133. ORATA, P. T., *The Theory of Identical Elements, Being a Critique of Thorndike's Theory of Identical Elements and a Re-interpretation of the Problem of Transfer of Training.* Columbus, O.: Ohio State Univ. Press, 1928.

134. PHILLIPS, A., Talented Imbeciles. *Psychol. Clin.*, 1930, **18**, 246–255.

135. PIALET, E., Recherches sur la fonction mnémonique de la forme et de la couleur dans les images colorées. *J. de Psychol.*, 1929, **26**, 101–121.

136. PILLSBURY, W. B., The Cinematoscope as a Memory Apparatus. *Amer. J. Psychol.*, 1929, **41**, 123.

137. PILLSBURY, W. B., *The History of Psychology.* N. Y.: Norton, 1929.

138. PLAUT, P., Zur Zeugenaussage Erwachsener. *Zsch. f. angew. Psychol.*, 1929, **32**, 321–342.

139. PLAUT, P., *Die Zeugenaussagen jugendlicher Psychopathen. Ihre forensische Bedeutung.* (Abh. a. d. Geb. d. Psychotherap. u. med. Psychol., Heft 8). Stuttgart: F. Enke, 1928.

140. RADECKA, H., and RADECKI, W., Pesquisas experimentaes da influencia do material mnemonico esquecido sobre a associação livre. *Ann. da Colon. de Psychopath.*, 1928, 1, 195–217.

141. RAZRAN, H. S., Theory of Conditioning and of Related Phenomena. *Psychol. Rev.*, 1930, **37**, 25–43.

142. RÉVÉSZ, G., Beschuldigung eines Lehrers wegen unzüchtiger Handlung durch seine Schülerinnen. *Zsch. f. angew. Psychol.*, 1928, **31**, 385–409.

143. RICHARDSON, L. F., Imagery, Conation and Cerebral Conductance. *J. Gen. Psychol.*, 1929, **2**, 324–350.

144. RIDGLEY, D. C., *A Study of Children's Learning About Places.* Worcester: Clark Univ. Press, 1928.

145. ROBINSON, E. S., Methods of Practice Equilibration. *Amer. J. Psychol.*, 1929, **41**, 153–156.

146. ROSENOW, C., Meaningful Behavior in Hypnosis. *Amer. J. Psychol.*, 1928, **40**, 205–235.

147. RUCH, T. F., Factors Influencing the Relative Economy of Massed and Distributed Practice in Learning. *Psychol. Rev.*, 1928, **35**, 19–45.

148. RUSSELL, R. D., A Comparison of Two Methods of Learning. *J. Educ. Res.*, 1928, **18**, 235–238.

149. SCHORN, M., Experimentelle Untersuchungen über die Mehrfachhandlung. *Zsch. f. Psychol.*, 1928, **108**, 195–221.

150. SEIFERT, P., Experimentell-psychologische Untersuchungen über die Reproduktion von Intervallen. *Arch. f. d. ges. Psychol.*, 1929, **67**, 307–436.

151. SELL, L., Beschreibung eines normalen zwölfjährigen Knaben. *Zsch. f. angew. Psychol.*, 1928, **29**, 463–532.

152. SELZ, O., Über die Abhängigkeitsbeziehungen zwischen Lernlust und Lernerfolg. (Experimentelle Untersuchungen über den natürlichen Lernvorgang. II. Ed. by O. Selz.) *Zsch. f. Psychol.*, 1928, **109**, 191–209.

153. SELZ, O., Schulbeispiel zur Frage der Würdigung jugendlicher Zeugenaussage. *Monatschr. f. Krimpsychol. u. Strafrechtsref.*, 1928, **11**, 641–658.

154. SENGUPTA, N. R., and BOSE, S. K., An Experimental Study of Definitely and Indefinitely Directed Attention. *Indian J. Psychol.*, 1929, **4**, 115–118.

155. SEWARD, G. H., Recognition Time as a Measure of Confidence. *Arch. Psychol.*, 1928, **16**, No. 99. Pp. 54.

156. SKAGGS, E. B., The Relation of Length of Material and Number of Repetitions Needed to Learn. *J. Gen. Psychol.*, 1929, **2**, 150–152.

157. SKAGGS, E. B., The Major Descriptive Categories of Inhibition in Psychology. *J. Abn. and Soc. Psychol.*, 1929, **24**, 310–317.

158. SOMMER, R., Ein Erinnerungsversuch zu zweit. *Zsch. f. Psychol.*, 1929, **112**, 256–259.

159. SPIELREIN, I., Die Realität von Wortinhalten und ihre Reproduzierbarkeit. *Zsch. f. angew. Psychol.*, 1928, **29**, 402–404.

160. SPIGHT, J. B., Day and Night Intervals and the Distribution of Practice. *J. Exper. Psychol.*, 1928, **11**, 397–398.

161. STANOYEVITCH, L., De l'amnésie verbale pour les couleurs dans la paralysie générale. Étude clinique psychopathologique. *Monde méd.*, 1928, **38**, 20–26.

162. STERZINGER, O., Über die sog. Verteilung der Aufmerksamkeit. *Zsch. f. angew. Psychol.*, 1928, **29**, 177–196.

163. STODDARD, G. D., An Experiment in Verbal Learning. *J. Educ. Psychol.*, 1929, **20**, 452–457.

164. STOKE, S. M., Memory for Onomatopes. *Ped. Sem. and J. Genet. Psychol.*, 1929, **36**, 594–596.

165. STRICKLER, C. B., A Quantitative Study of Post-hypnotic Amnesia. *J. Abn. and Soc. Psychol.*, 1929, **24**, 108–119.

166. TESORO, G., *La psicologia della testimonianza.* Torino: Fratelli Bocca, 1929.

167. THORNDIKE, E. L., BREGMAN, E. O., TILTON, J. W., and WOODYARD, E., *Adult Learning.* N. Y.: Macmillan, 1928.

168. THURSTONE, L. L., The Relation Betwcen Learning Time and Length of Task. *Psychol. Rev.*, 1930, **37**, 44–53.

169. TILTON, J. W., and KNOWLTON, D. C., The Contribution of Ten Chronicles-of-America Photoplays to Seventh-Grade History Teaching. *J. Soc. Psychol.*, 1930, **1**, 78–95.

170. TUCKER, B. R., and SHIELD, J. A., Amnesia; report of a case apparently benefited by operation. *J. Abn. and Soc. Psychol.*, 1928, **23**, 40–44.

171. VÉLINSKY, ST., La certitude associative. La base de la psychologie de l'apprentissage. *L'Ann. Psychol.*, 1927, **28**, 140–185.

172. VÉRTES, O. J., Siketnéma gyermekek emlékezete. *Psychol. Stud.* (Ranschburg-Festschrift), 1929, 210–216.

173. VOGELSANG, H., Experimentelle Untersuchungen über die Einprägung simultan gebotener Objekte. *Arch. f. d. ges. Psychol.*, 1929, **67**, 257–306.
174. WASHBURNE, J. N., The Use of Questions in Social Science Material. *J. Educ. Psychol.*, 1929, **20**, 321–359.
175. WEBER, H., Untersuchungen über die Ablenkung der Aufmerksamkeit. *Arch. f. d. ges. Psychol.*, 1929, **71**, 185–260.
176. WHEELER, R. H., *The Science of Psychology*. N. Y.: Crowell, 1929.
177. WHITELY, P. L., and MCGEOCH, J. A., The Curve of Retention for Poetry. *J. Educ. Psychol.*, 1928, **19**, 471–479.
178. WILEY, J. A., 40 Choice Ways of Learning and Recalling. Cedar Falls, Ia.: Author, 1928.
179. WILLOUGHBY, R. R., Incidental Learning. *J. Educ. Psychol.*, 1929, **20**, 671–682; 1930, **21**, 12–23.
180. WORCESTER, D. A., The Permanence of Learning in High School Subjects—Algebra. *J. Educ. Psychol.*, 1928, **19**, 343–345.
181. YOUNG, M. H., A Comparative Study of Audito-Vocal Digit Spans. *Psychol. Clin.*, 1928, **17**, 170–183.
182. ZILLIG, M., Typisches Verhalten kindlicher Zeugen bei wiederholter Aussage. *Zsch. f. Psychol.*, 1928, **107**, 366–410.

The writer has depended upon abstracts in English, French and German for the content of papers in languages other than the three mentioned.

NOTES AND NEWS

DR. HORACE B. ENGLISH has been appointed Professor of Psychology in the Ohio State University. Dr. Clarence Leuba, Lecturer in Psychology at Bryn Mawr, has been appointed Associate Professor of Psychology at Antioch College.

PROFESSOR MAX F. MEYER, of the University of Missouri, has been appointed research professor of psychology for one year, and has been relieved from all his teaching and administrative duties. His work will be concerned with methods of teaching the deaf and will be carried on with the clinical facilities of the Central Institute for the Deaf in St. Louis.

DR. A. T. POFFENBERGER, Columbia University, and Dr. Calvin P. Stone, Stanford University, have been elected representatives of the American Psychological Association on the Division of Anthropology and Psychology of the National Research Council. Dr. E. S. Robinson, Yale University, has been elected a member-at-large.

MR. C. W. MASON, M.A., Buffalo, 1930, and Mr. A. W. Melton, M.A., Yale, 1929, have been appointed Research Associates of the American Association of Museums. The former will serve as acting staff psychologist of the Buffalo Museum of Science, and the latter will serve similarly at the Pennsylvania Museum in Philadelphia. These appointments have been made in connection with a two-year research program of the American Association of Museums. A grant for this work was recently made by the Carnegie Corporation.

DR. HELEN THOMPSON WOOLEY, professor of education and director of the Child Development Institute of Teachers College, Columbia University, has presented her resignation to take effect on September 1.

AT Yale University, Dr. Mark A. May has been appointed director of the statistical bureau of the Institute of Human Relations, Professor Walter R. Miles and Dr. Catherine Cox Miles of Stanford University have been appointed research associates in psychiatry and psychology for one year.

DR. HULSEY CASON has accepted appointment as professor of psychology in the University of Wisconsin.

DR. PAUL L. BOYNTON has been appointed professor in the George Peabody College for Teachers.